Established 1916 as The OIL WEEKLY®

VOLUME 152, NO. 1 JANUARY 1961

WORLD OIL

A Gulf Publishing Company Publication

SPECIALIZED FOR EXPLORATION, DRILLING AND PRODUCING OPERATIONS AND MANAGEMENT

SPECIAL REPORT/NORTH AFRICA

Introduction ... 61
So you're going to North Africa
Joseph A. Kornfeld ... 63
The Sahara, largest and most arid desert in the world ... 65
Las Palmas, West Africa's offshore operating base ... 67
Widespread exploration underway in new French Community ... 68
New door-to-door service eases moving problems ... 69
Lower Paleozoic prospects enhanced in Sahara ... 71
Know your basement in North Africa ... 73
How the Sahara's geophysical problems are being solved ... 76
How the contractor drilled first Spanish Sahara well ... 78
Drilling in the Libyan desert ... 80
France moves to diversify Sahara crude oil markets ... 83
Plans for moving Sahara gas to European markets ... 84

CURRENT OUTLOOK

Increased demand forecast in 1961 ... 13
Must Congress be pressured into keeping its promise? ... 17
Good demand causes strong fuel oil markets ... 25
November drilling down slightly ... 28
Rocky Mountain Four-Basin report (Part 2) ... 101

EXPLORATION

Tyler sand trend becoming better known in Dakotas
Frank W. Foster ... 89

DRILLING

Magnetic particle inspection pays off
Walter A. Henkes ... 94
Time-setting clay cement controls lost circulation
J. U. Messenger ... 110

PRODUCTION

How to improve your hydraulic pumping operations
John B. Woods ... 85
Gas injection program pays off in South Louisiana
L. G. Shivers ... 97
How to estimate equivalent gas volume of stock tank condensate
Allen G. Leshikar ... 108

DEPARTMENTS

Looking ahead	13	Associations	147
Editorial page	17	Suppliers' notes	156
Changing panorama	25	Squeaks from the bullwheel	164
Drilling activities	28	Trading Post	169
Practical operating hints	32	Classified advertising	169
Your industry at work	130	What's new in equipment	170
Men in the industry	138	New literature	176
Who's meeting where	144	Advertisers in this issue	182

WORLD OIL published every month except semi-monthly in Feburary and August. Second class postage paid at Houston, Texas. ©Gulf Publishing Co. 1961.

A Quick Look at This Issue

2420

BUSY OIL MEN: To help you put first things first, scan these time-saving digests on this and the following pages, checking ☐ those you want to read first.

NORTH AFRICA—NEW OIL AND GAS FRONTIER

☐ **One of the significant technical achievements** of the postwar era is the emergence of North Africa as a major oil and gas producer.

Much of the credit must be given to France, for it was this country's persistence and technical ability that resulted in the prolific 1956 Algerian Sahara discoveries—after decades of frustrating search in one of the world's most desolate areas. And it was the French who solved the difficult problem of moving oil and gas from the interior of the Sahara to Mediterranean ports.

Because of the intense interest shown in this new oil and gas frontier, WORLD OIL commissioned internationally known geologist Joseph A. Kornfeld to obtain an on-the-scene report covering every aspect of North Africa's oil and gas development. The results of his efforts, and extensive WORLD OIL research, are published in the exclusive report, starting on ..... **Page 61**

In the report you will find:

- Statistical information on North Africa's rapid growth as an oil and gas area ..... Page 63
- Detailed analyses of living conditions, climate and topography ..... Page 65
- Efforts being made to expand exploration ... Page 68
- New techniques in moving personnel overseas. Page 69
- Seven-page report on the geology of the area. Page 71
- Two exclusive articles describing drilling conditions in Libya (Page 80) and the Spanish Sahara (Page 78)
- France's plans to move North African oil and gas to Europe ..... Page 83

In addition, you will find a 40x28-inch fold-out map showing the latest oil and gas developments in North Africa. Included on the map are concessions for each

country—oil and gas fields—significant new wells drilled —major basins—pipe lines—refineries—and cities with airports.

Extra copies of the map are available at $1 each. You may order your copy by filling out the Readers' Service card on page 183, and mailing it to WORLD OIL.

☐ **How to improve your hydraulic pumping operations . . .** The hydraulic dynamometer can be used to increase operational efficiency of hydraulic pumping wells. For an informative description of the dynamometer and its applications, plus several examples of interpreted dynamometer cards from various types of wells, turn to.....Page 85

☐ **Tyler sand trend becoming better known in Dakotas . . .** The basal Pennsylvanian Tyler sands have become an important source of oil in the Williston Basin. In recent years stratigraphic work has placed the Tyler immediately above a post-Mississippian, pre-Pennsylvanian unconformity. Previous literature has shown this relationship in Montana. Emphasis is placed on the

Why World Oil leads the field . . .

How does WORLD OIL maintain its reputation as the trade publication that constantly provides its readers with maximum editorial service? The answers are threefold:

- Alert, progressive management.
- Experienced, efficient staff.
- Constant personal staff contact with men in the industry at the management and field level. This means thousands of miles of travel each year, plus WORLD OIL-sponsored editorial conferences where top industry personnel are invited to offer their ideas for improving editorial quality.

In keeping with this philosophy, WORLD OIL invited industry guests* to attend its 1960 Editorial Conference at Fort Clark (Bracketville, Texas), November 30-December 4. Seven meetings were held to evaluate present editorial content and to develop article ideas for the 14 issues WORLD OIL will publish in 1961.

Guests, shown seated at the table, included (from left to right): Richard J. Goeken, area petroleum engineer, Gulf Oil Corporation, New Orleans; Carl Kinney, regional drilling manager, The Atlantic Refining Company, Lafayette, La.; J. J. Reynolds, chief engineer, Continental Oil Company, Houston and James E. Pryor, drilling superintendent, Helmerich & Payne, Inc., Odessa, Texas.

Staff members, from left to right: Fred Colby, advertising service manager; R. B. Reilly, circulation manager; Harrison T. Brundage, exploration editor; Wallace Fitzgerald, managing editor; Gilbert M. Wilson, district editor; L. J. Logan, associate editor; Jack F. Earl, drilling editor; Donald E. Kliewer, editorial director; Robert W. Scott, production editor; Don E. Lambert, associate editor; R. M. de Sombre, vice president, and Anthony Gibbon, district editor.

* Attendance by oil men at WORLD OIL editorial conferences does not necessarily constitute an endorsement of WORLD OIL by the companies for which they work. But it is an indication of the cooperation existing between the industry and its press.

extension of this important trend into North and South Dakota, and on the primarily stratigraphic nature of oil traps in the Tyler sands.....Page 89

☐ **Magnetic particle inspection pays off . . .** A planned program of weld inspection in mast and related drilling equipment at intervals of from one to two years—and more frequently if the unit has seen unusually severe service—is paying dividends for numerous drilling contractors and operators. For the techniques involved, plus a number of actual case histories that illustrates the cost saving potential, turn to.....Page 94

☐ **Gas injection program pays off in South Louisiana . . .** The Atlantic Refining Company's miscible phase displacement project in Neale field has tripled production, increased ultimate recovery from 16 to 54 percent, and reduced per well operating costs 80 percent. Plant product recovery has been increased 250,000 barrels over that predicted under primary conditions. For complete details on this profitable secondary recovery project, turn to.....Page 97

☐ **Rocky Mountain four-basin report (Part 2) . . .** Four of the most active drilling areas in the Rocky Mountains are the Powder River, Green River, Wind River, and Big Horn basins. Recent prolific discoveries have sparked new interest in these areas. To bring World Oil readers up to date on this promising oil and gas province, a detailed report on the Powder River and Green River basins was published in December. This month, a complete activity and geological report on the Wind River and Big Horn basins is presented, starting on.....Page 101

☐ **How to estimate equivalent gas volume of stock tank condensate . . .** Curves have been developed which provide an easy means for estimating equivalent gas volumes of stock tank condensates. The equivalent gas volume then can be added to the metered residue gas volume to obtain the full well stream volume now required by the Texas Railroad Commission. Only lease separation pressure and gravity are required to use the curves. See.....Page 108

☐ **Time-setting clay cement controls lost circulation . . .** This new cement has been successfully used where multiple fracture systems and small cavernous zones are present. For complete information on numerous field results and various methods of application, turn to.....Page 110

Oil Industry in Brief

Here are the latest industry trends, revealed by WORLD OIL and industry research.

Outlook: Good. Texaco board chairman says domestic petroleum demand will increase 2-3 percent in '61, foreign demand will be up 7 per cent. He adds, "At the close of 1960 the industry is in better shape both as to total inventories and prices, than last year." . . . See Page 13.

Fuel oil markets improve. After slow November due to mild weather, December cold snap boosted fuel oil use to near record 1959 level. Moderate price increase in distillates was generally accepted. . . . See Page 25.

Gasoline stocks up. At November's end, they totaled 187.3 million barrels, up 6.3 million or 3.5 percent over November 1959—while demand increased only 1 percent in November. . . . See Page 25.

Supply meets demand. Imports, crude production, and natural gas liquids output were boosted nearly 300,000 barrels per day in November. Thus, only 23,000 barrels per day were supplied from storage. . . . See Page 25.

Completions down. Operators completed 133 new wells per day in the U.S. during November, down 2 wells per day from October, and up slightly from 132 wells per day during November 1959. . . . See Page 28.

Rig totals drop. 3,623 rigs were operating on November 30, down 141 from October's end and down 362 from November 30, 1959. . . . See Page 28.

1960 in brief. During first 11 months, new crude oil completions were down 3,133 wells or 13.4 percent, new distillate completions were down 30 wells or 4.1 percent, while new gas completions increased 218 wells or 5.9 percent. . . . See Page 28.

Coming in February . . . WORLD OIL's annual Forecast-Review Issue

HOW TO CUT OIL WELL

Strata-Crete 6 Gives More by Actual Comparison

ADDITIVES	STRATA-CRETE 6 (Expanded Perlite plus Perlite fines)	GILSONITE	BENTONITE	POZZOLAN	HOW DOES YOUR ADDITIVE COMPARE?
SLURRY DENSITY	12.7 lbs. per gallon at 3000 psi	12 to 12.5 lbs./gal.	13.0 lbs./gal.	14.1 lbs./gal.	
BRIDGING QUALITIES	excellent; highest available in any commercial additive	fair, but requires large amount of material	none	none	
PERFORMANCE COST	low, since you get high fill-up relative to material used.	moderate to high; some fill-up advantages	low initial cost; but cost may be high to obtain performance	low initial cost; no bridging qualities may make performance cost high	
SCOURING ACTION	excellent	fair	none	none	
PERFORATING QUALITIES	excellent, non-shattering	good	fair	good	
EASE OF PLACEMENT	good	good	good	good	
INERTNESS	chemically inert	soluble in some hydrocarbons	readily attacked by corrosive waters, acids, and alkali solutions	inert	
MELTING POINT	above 1500°F	300°F plus			
COMPRESSIVE STRENGTH	good	good	good	good	
THICKENING TIME	actually extends time	will not accelerate	will accelerate under certain conditions	will not accelerate	

. . . in stock and ready for delivery from CURTIN

NEW ASTM SHORT CONE SHAPE BS&W TUBE

W. H. Curtin & Company has on hand complete stocks to fill your requirements in converting to the new Short Cone Shape BS&W Tube approved at the June 1960 meeting of ASTM Committee D-2. Standard ASTM 100-ml tubes or tubes graduated in 200 parts, hand and motor-driven centrifuges, plus all accessories needed for converting your present equipment are available at all Curtin locations. Curtin Bulletin CT-660-1 shows exactly what is required to convert each type of centrifuge now in use. **Ask your Curtin salesman or write W. H. Curtin & Co., Box 118, Houston 1, Texas.**

W. H. CURTIN & CO.

CURTIN

PETROLEUM TESTING EQUIPMENT

HOUSTON • DALLAS • TULSA • NEW ORLEANS
JACKSONVILLE • BIRMINGHAM • CORPUS CHRISTI
CURTIN DE MEXICO, S. A. DE C. V., MEXICO, D. F.

110

WORLD OIL

RAY L. DUDLEY, Founder, 1891-1957

WILLIAM G. DUDLEY.....Publisher
DONALD E. KLIEWER.....Editorial Director
L. J. LOGAN.....Associate Editor
DON E. LAMBERT.....Associate Editor, Current Outlook
WALLACE FITZGERALD.....Managing Editor
ROBERT W. SCOTT.....Engineering Editor
JACK F. EARL.....Engineering Editor
HARRISON T. BRUNDAGE.....Exploration Editor
GILBERT M. WILSON.....Western District Editor
ANTHONY GIBBON.....Mid-Continent District Editor
JACK COCKERHAM.....Presentation Editor
FERN C. REED.....Editorial Assistant
JOHN BRADLEY.....Editorial Assistant
DOLORES REYNOLDS.....Editorial Assistant
GARY DUNHAM.....Editorial Assistant
EUNICE M. OKONESKI.....Librarian

WORLD OIL
Is Published By
GULF PUBLISHING COMPANY

EXECUTIVE OFFICES: 3301 BUFFALO DRIVE, HOUSTON
Cable Address, Gulfpubco, Houston
World's Largest Specialized Publishers to the Oil Industries

WILLIAM G. DUDLEY.....President
TOM W. NELSON.....Vice Pres.-Gen. Mgr.
R. M. DE SOMBRE.....Vice Pres.-Asst. Gen. Mgr.
NELSON L. BIGELOW.....Vice President Sales
MRS. RAY L. DUDLEY.....Vice President
P. J. AUCOIN.....Treasurer

ADVERTISING

Nelson L. Bigelow, Advertising Sales Manager, Houston

HOUSTON (1)—P. O. Box 2608
Charles Wyatt, C. A. Davis, Cecil W. Smith
Phone JAckson 9-4301

SUMMIT, NEW JERSEY—382 SPRINGFIELD AVE.
Sam Sorrell, Phone CRestview 7-1221

CLEVELAND (16)—20800 CENTER RIDGE ROAD
Bill Westfall, Phone EDison 3-1650

CHICAGO (46)—6039 N. CICERO AVENUE
Al Seymour, Phone AVenue 2-4333

LOS ANGELES—1810 FAIR OAKS AVE., SOUTH PASADENA
Jay Curts, Jim Merrill, Phone MUrray 2-3518

TULSA (3)—916 ENTERPRISE BUILDING
Jim Isaacks, Phone LUther 2-9211

DALLAS (8)—1808 SYLVAN DRIVE
Ed Thompson, Phone RIverside 7-7344

LONDON, ENGLAND—120 MOORGATE, E. C. 2
Frank Chambers, Agent, Phone MOnarch 5661

KOLN-BRAUNSFELD, GERMANY—AACHENER STRASSE 378,
Gerd Hinske, Phone 52 22 60

Advertising rates on application.

SUBSCRIPTIONS

R. B. Reilly, Circulation Manager, P. O. Box 2608, Houston 1, Texas, U.S.A. Single copies 50 cents (except special issues). Double prices for single copies more than a year old. Subscription rates: both foreign and domestic $2 a year. Copyright 1961 by Gulf Publishing Company. WORLD OIL and THE OIL WEEKLY are registered trademarks of Gulf Publishing Company, Houston, Texas.

Postmaster: Send notification (Form 3579) regarding undeliverable magazines to WORLD OIL, Box 2608, Houston 1, Texas.

GPC PUBLICATIONS

WORLD OIL (formerly The Oil Weekly) and The COMPOSITE CATALOG for the drilling-producing industry.
PIPE LINE INDUSTRY and The PIPE LINE CATALOG for the oil and gas pipe line industry.
PETROLEUM REFINER and The REFINERY CATALOG for the oil, gas and petrochemical processing industry.

Indexed by Industrial Arts Index and Engineering Index

Save on oil exploration and production costs with '61 FORD TRUCKS

FORD HEAVIES SAVE WITH DOUBLE THE CAB, SHEET METAL AND RADIATOR LIFE

Ford F-Series Heavy Duty models are especially designed for the rugged terrain and tough conditions generally found on exploration and production jobs. Their new independent mounting system for cab and radiator effectively separates both from the adjacent sheet metal assemblies for much greater durability. And radius rod-leaf type rear springs provide better axle alignment, longer spring life.

The electrical wiring system has been improved for greater reliability. Chassis wiring is fastened within the protection of the frame web, away from mud, ice and snow. Ford Truck frames have been engineered to make the mounting of bodies and special equipment easier. And a new 212-inch wheelbase model is available to accommodate extra-long bodies.

Save with Ford Heavy Duty Tandems for exceptional durability, payloads and low operating expenses. Ford T-700, T-750 and T-800 Tandems with HD V-8 engines have rugged double-channel frames that are built to take tortuous off-road treatment. And they provide a wider range of chassis options so you can choose the right power train and load-carrying components for any job. Eaton and Timken rear axles are now available in bogie assemblies with 22,000-, 28,000-, 30,000- and 34,000-lb. capacities. And lightweight aluminum walking beams, wheels and gas tanks are available to keep chassis weights low . . . payloads high.

Ask your Ford Dealer about Ford's full tandem line . . . including Super Duties with 38,000-lb. bogies for up to 51,000-lb. GVW!

Looking Ahead for '61

Technological outlook: no revolutionary changes, but several improvements on the way . . . Continued efforts to cut exploration, drilling and production costs will result in several new technological developments this year. Some already have been introduced:

Underwater completions. First U.S. offshore underwater completion will be attempted by Richfield on state oil and gas lease at Rincon, Ventura County, California. Company will use same method employed in Peru offshore project.

Computers. Operators will make more widespread use of small computers for production operations.

Hammerdrill. Extensive tests during 1960 have proved the merits of this new percussion tool in hand rock formations, i. e., penetration rate is faster than conventional methods, holes are straighter, bits last longer, slower rotation and less bit weight are required, resulting in lower air drilling costs. Drill is installed between bit and drill collar, uses compressed air to drive hammer about 1,800 blows per minute with 350 psi inlet air pressure.

Aluminum drill pipe. Further tests to determine economic feasibility will be made in 1961, after promising results from Shell's 10,400-foot test in south Texas during 1960.

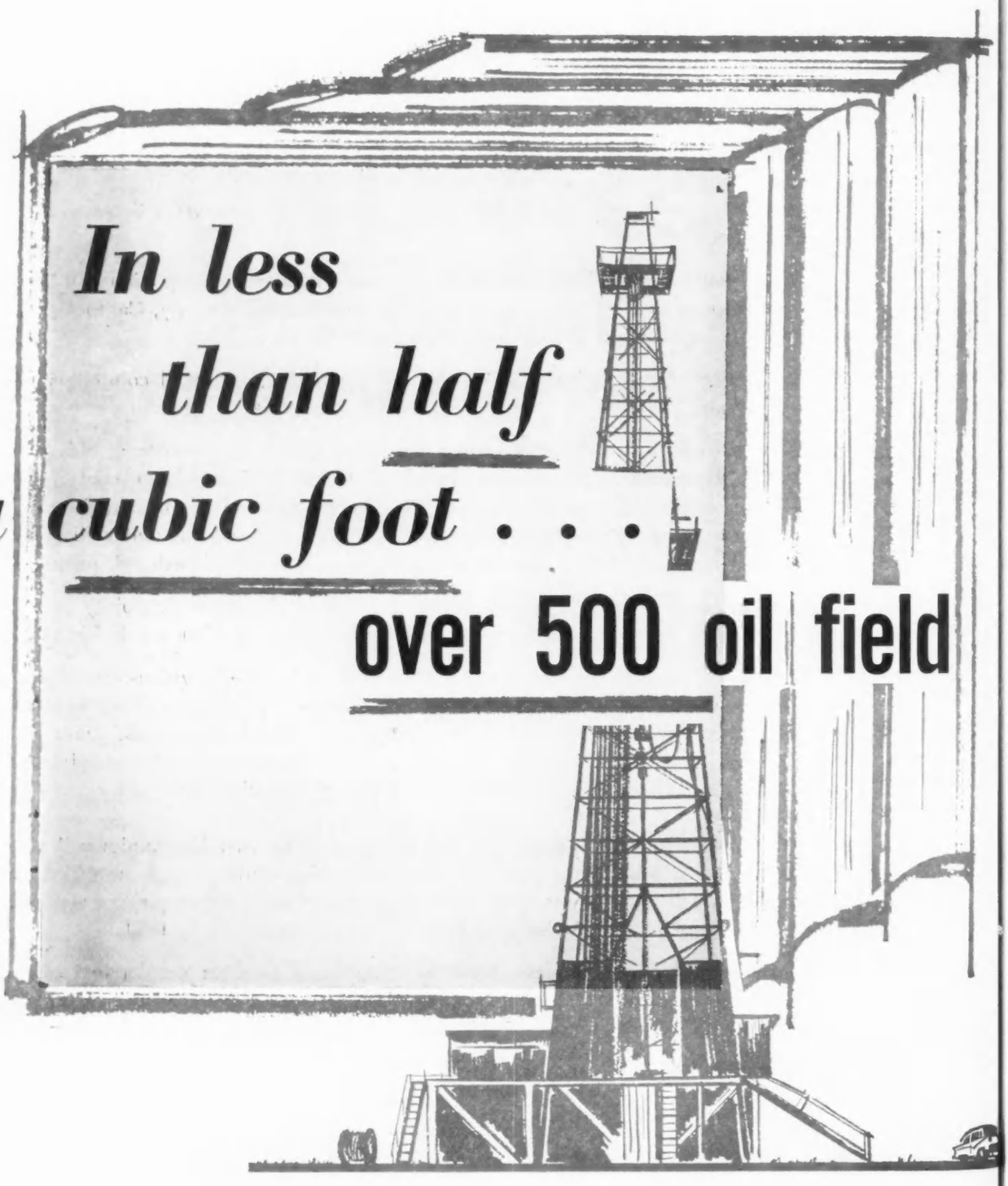
Shot hole logging. Exploration will be improved by more widespread logging of seismic shot holes and shallow core tests. Continuous velocity logging of shot holes, heretofore done primarily by a major company with experimental shop-made tools (WORLD OIL, October 1960, pp. 160-168) will provide more thorough shallow geologic and seismic data from instruments now being developed and field tested.

Economic outlook: no boom, but no bust, either . . . Companies will take closer look at capital expenditures, with eye toward slowing down trend toward excessive crude and product inventories, small tract drilling and rapid refinery expansion. Economic temperance and self regulation will become popular by-words in 1961.

Indiana Standard President John E. Swearingen predicts that in first half of 1961 domestic crude and product demand will increase 1-2 percent and earnings will be up 5 percent, over first half of 1960. Recent price improvements should continue.

Texaco's Board Chairman Augustus C. Long forecasts domestic demand will increase 2-3 percent this year, overseas demand will be up 7 percent.

Government outlook: no concerted action against the industry, but watch out for increased federal control . . . Look for President Kennedy to hold tighter personal rein on regulatory agencies than did Eisenhower and for those agencies to be much more closely coordinated than before—**Moves to create a national fuels policy** and to reduce percentage depletion will have Administration support—**There will be no significant change in the imports program,** though some reductions in District IV will be forthcoming—**Industry supported natural gas bill will be introduced,** but will make frustratingly slow headway during this session—**Courts are not expected to accept FPC's new area pricing plan for natural gas,** as set up under present policy. However, more realistic establishment of area boundaries and efforts to eliminate dual prices will improve plan somewhat.


In less
than half
a cubic foot . . .
over 500 oil field

Must Congress be pressured into keeping its promise?

THE TEMPORARY one-cent federal gasoline tax increase which went into effect in 1959 is scheduled by law to expire next June 30. But will it?

Apparently, the hope that it will be allowed to expire depends again upon the continuing pressure that can be brought to bear on Congress simply to keep its word. And, plainly, that is a sorry state of affairs.

After repeatedly rejecting efforts to raise the federal gasoline tax in 1959, Congress finally agreed to a temporary one-cent increase when agreement could not be reached on an alternate method of keeping the federal highway program in the black. The fourth cent added to the tax on October 1, 1959, marked the third boost in the federal rate since 1951!

Of course, that rise brought the combined national average of federal and state taxes to more than ten cents a gallon. Nationally, these combined taxes now average 48 percent of the retail price of regular grade gasoline, 62 percent of the wholesale price and 85 percent of the refinery price. In 20 states, taxes amount to more than half of the retail price, and equal the refinery price in some areas.

Compromise agreement. The temporary one-cent tax was intended as a part of a compromise agreement calling for application to other automotive excise taxes to the highway program when the gasoline tax increase expires in June. Without this condition, the bill to increase the tax could never have gone through Congress.

Now, if Congress should renege on this arrangement next June, such action would be a glaring example of bad faith toward highway users throughout the United States.

Despite the obvious severity of the tax burden now being carried by gasoline alone, there has been—and is now—good reason to assume that exceedingly strong pressures will be exerted to retain the fourth cent of the federal tax when its previously promised expiration date arrives.

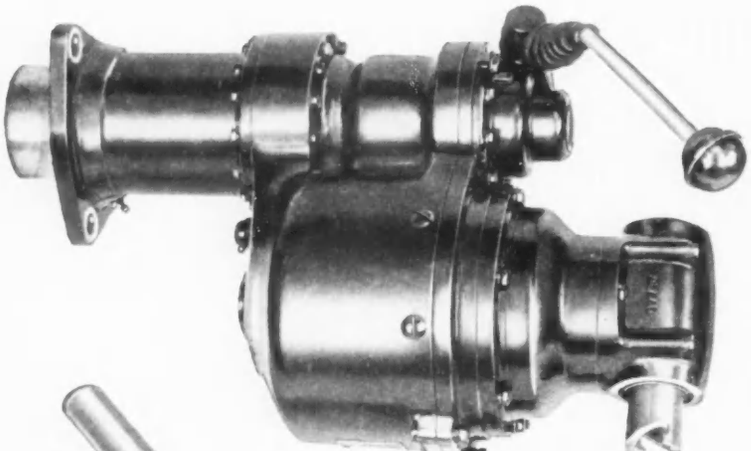
The shadow of things to come is quite clear even now: unless the U.S. motorist puts his foot down hard—and continues to keep it there until June 30—there may be no letup in demands to increase the gas tax again and again and again.

Petitions circulated. An integral part of the oil and gas industry-wide public education program to bring facts about gasoline taxation to motorists' attention was launched last October. It was the nation-wide effort in the form of petitions, signed by motorists, requesting reduction as promised by Congress in the federal gasoline tax.

Thousands of signatures supported the petition. In many instances, motorists signing the request did not appear to appreciate the extremely high level reached by gasoline taxes. But they are learning—and fast. For it is they who are paying the bill. They are the same individuals who expect the Congress to keep its word by allowing this temporary tax increase to die on June 30.

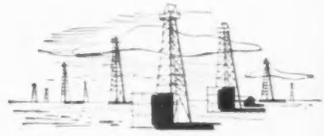
However, the oil and gas industry must not relent for a moment the effort to quash efforts to retain the tax increase. If an ally is required to pressure Congress into keeping its word, then the U.S. motorist is a good one. And he has an open ear to facts.

FOR READY STARTS...



MARINE

CONSTRUCTION



OIL

MINING

AGRICULTURE

BENDIX AE INERTIA STARTER

More easily mounted and in more positions • Can be installed in ten minutes without the use of any special tools • Completely self contained . . . no "extras" to buy.

Requires **NO CABLES, NO PUMPS, NO PLUMBING.**

The Bendix* AE Inertia Starter is rugged and dependable under difficult operating and climatic conditions. It is especially suited for use in remote areas where battery maintenance is a problem, or where there is a fire hazard. For complete information, write:

*Registered Trademark

Bendix International DIVISION — THE Bendix CORPORATION

205 E. 42ND ST., NEW YORK 17, N.Y., U.S.A.

CABLE ADDRESS: "BENDIXINT", N.Y.

Good demand causes strong fuel oil markets

Prices of distillate advance at middle of December, as cold weather stimulates consumption. But there is a threat that gasoline stocks may become excessive

By WORLD OIL Staff

TRENDS OF BUSINESS volumes and operating results for oil companies have continued encouraging. November was milder in 1960 than in 1959, and petroleum sales consequently fell somewhat short of the all time records set in November a year ago. But a reverse situation prevailed in the first half of December 1960, as extremely cold weather contrasted with a milder December 1959.

The snow and ice of December this year will result in heavy consumption of heating oils as well as kerosine. Residual fuel oil consumption also should be extremely high, with large volumes used by industry in lieu of natural gas, under contracts giving residential customers first call on gas when supplies are inadequate for all users.

At mid-December 1960 it seemed very likely that distillate fuel oil sales for the month would exceed those of December 1959, when milder weather prevailed.

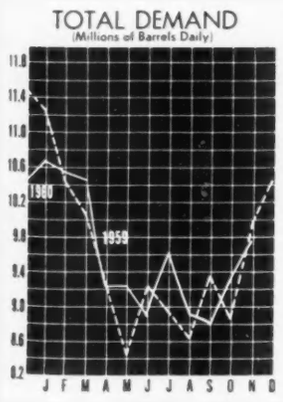
Similarly, distillate fuel oil demand in January 1961 very likely will be greater than that in January 1960, since the latter month was unusually mild.

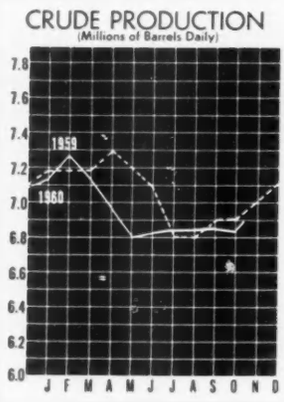
At the middle of December 1960 the market for distillate fuel oil was firm, despite ample stocks, and increases in wholesale and retail prices gained general acceptance. Prices were better than one year previously.

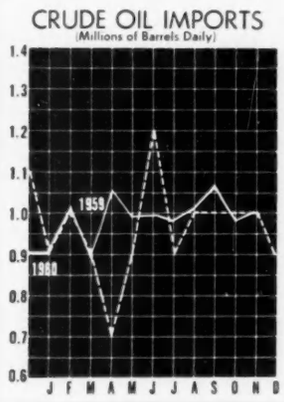
Gasoline. The gasoline situation remained the principal threat to the industry's welfare. Gasoline sales continued fairly satisfactory, showing small gains over one year previously. But gasoline stocks were larger than desirable. At the end of November they totaled 187.3 million barrels, an increase of 6.3 million or 3.5 percent over November 1959. This increase was not justified by demand, which was up only 1 percent in November and 1.4 percent for the first 11 months of 1960.

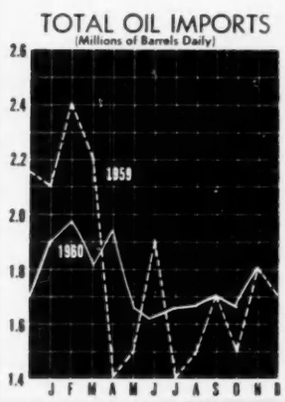
Because of the cold weather of December, there was danger that the surplus of gasoline would increase. The weather situation called for large production of distillate fuel oil, high refinery runs, and necessary large production of gasoline at the same time. There is a definite possibility that gas-

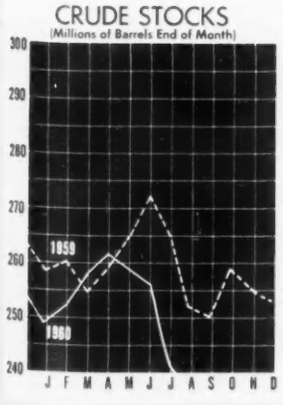
Petroleum Trends...

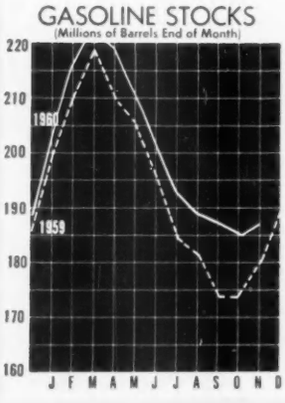


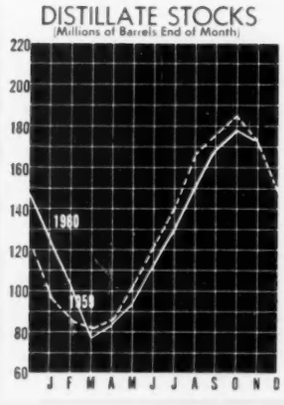


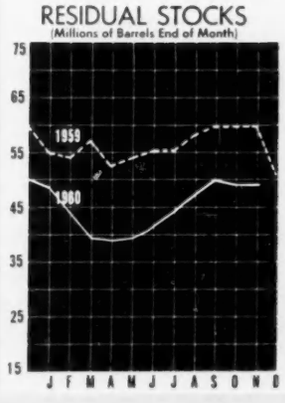












U. S. Petroleum Demand and Supply (Thous. Bbls. Daily)

ITEM	NOVEMBER 1960	NOVEMBER 1959	% Diff.	Oct. 1960	JANUARY-NOVEMBER 1960	JANUARY-NOVEMBER 1959	% Diff.
DEMAND							
All Oils, Total Demand	9,771	10,044	— 2.7	9,325	9,708	9,536	+ 1.8
Domestic Demand	9,576	9,858	— 2.9	9,125	9,502	9,297	+ 2.2
Export Demand	195	186	+ 1.0	200	205	239	— 14.2
Gasoline, Total Demand	3,994	3,920	+ 1.0	4,110	4,177	4,118	+ 1.4
Distillate, Total Demand	2,122	2,225	— 4.6	1,450	1,792	1,768	+ 1.4
Kerosine, Total Demand	428	393	+10.9	339	342	285	+20.0
Residual, Total Demand	1,513	1,717	—11.9	1,319	1,536	1,571	— 2.2
Other Oils, Total Demand	1,714	1,789	— 4.2	2,107	1,861	1,794	+ 3.7
CHANGE IN STOCKS							
All Oils, Change in Stocks	—23	—313		+116	+32	+141	—77.3
NEW SUPPLY							
Total New Supply	9,748	9,732	+ 1.0	9,441	9,740	9,677	+ 0.7
Domestic Production, Total	7,956	7,902	+ 0.7	7,762	7,931	7,914	+ 0.2
Crude Oil	6,971	6,982	— 0.2	6,822	6,998	7,041	— 0.6
Natural Gas Liquids	985	920	+ 7.1	940	933	873	+ 6.9
Imports, Total	1,792	1,829	— 2.0	1,679	1,808	1,762	+ 2.6
Refined Products	784	849	— 7.7	721	789	803	— 1.8
Crude Oil, Total	1,008	980	+ 2.9	958	1,019	959	+ 6.3
Crude, East of California	728	712	+ 2.2	699	746	730	+ 2.2
CRUDE RUNS							
Crude Runs to Stills	7,902	7,984	— 1.0	7,905	8,070	7,980	+ 1.1
Domestic Crude	6,914	6,937	— 0.3	6,812	7,045	7,020	+ 0.4
Foreign	988	1,047	— 5.6	1,093	1,026	960	+ 6.9

U. S. Stocks of Oils (Million Bbls. at End of Month)

KIND OF OIL	TOTAL IN U.S. Nov. 1960	TOTAL IN U.S. Nov. 1959	% Diff.	TOTAL IN U.S. Oct. 1960	EAST OF CALIFORNIA Nov. 1960	EAST OF CALIFORNIA Nov. 1959	% Diff.	EAST OF CALIFORNIA Oct. 1960
All Oils	823.2	836.5	— 1.6	823.9				
Crude Oil	237.6	255.9	— 7.2	231.3	206.9	223.1	— 7.3	200.4
Gasoline	187.3	181.0	+ 3.5	185.4	160.6	154.2	+ 4.2	159.4
Distillate Fuel Oil	173.1	171.1	+ 1.2	179.8	159.0	156.8	+ 1.4	165.9
Kerosine	36.9	30.7	+20.2	36.7	38.4	30.3	+26.7	35.3
Residual Fuel	49.3	58.6	—15.9	49.4	34.2	33.6	+ 1.8	33.7
Other Oils	139.0	139.2	— 0.1	141.3				

U.S. Crude Oil Production, by States (Thous. Bbls.)

STATE or DISTRICT	Daily Average for Month Nov. 1960	Nov. 1959	% Diff.	Oct. 1960	Total, January-November 1960	1959	% Diff.
Alabama	21.7	13.8	+ 57.2	19.9	6,597	4,554	+ 44.9
Arkansas	75.6	62.8	+ 20.4	77.4	26,170	24,254	+ 7.9
California	831.7	838.8	— 0.9	824.7	278,344	281,418	— 1.1
Colorado	132.2	126.5	+ 4.5	132.1	43,148	42,156	+ 2.4
Florida	1.0	1.1	— 9.1	1.0	343	388	— 11.6
Illinois	225.1	214.6	+ 4.9	217.9	72,670	71,610	+ 1.5
Indiana	32.3	31.3	+ 3.2	31.7	10,664	10,966	— 2.8
Kansas	303.4	324.7	— 6.6	302.0	103,072	109,302	— 5.7
Kentucky	53.7	65.7	— 18.3	54.5	19,586	24,345	— 19.6
Louisiana	1,100.3	1,033.8	+ 6.4	1,071.6	357,311	322,003	+ 11.0
North Louisiana	110.5	132.5	— 16.6	110.5	41,273	41,570	— 0.7
South Louisiana	989.8	901.3	+ 9.8	961.1	316,038	280,433	+ 12.7
Michigan	47.5	32.7	+ 45.3	45.1	13,683	9,367	+ 46.1
Mississippi	149.5	142.7	+ 4.8	138.7	47,321	43,392	+ 9.1
Mo.-So. Dak.-Tenn.	0.7	0.7	.....	0.8	309	104	+197.1
Montana	82.3	81.4	+ 1.1	83.2	27,633	27,473	+ 0.6
Nebraska	65.7	68.0	— 3.4	66.9	22,217	21,586	+ 2.9
Nev.-Wash.-Alaska-Ariz.	1.0	1.0	.....	1.0	316	222	+ 42.3
New Mexico	295.2	295.9	— 0.2	291.8	99,087	96,467	+ 2.7
Southeast	258.9	248.6	+ 4.1	255.5	84,407	82,997	+ 1.7
Northwest	36.3	47.3	— 23.3	36.3	14,680	13,470	+ 9.0
New York	4.5	5.5	— 18.2	4.8	1,657	1,811	— 8.5
North Dakota	65.6	49.3	+ 33.1	62.9	19,924	16,073	+ 23.9
Ohio	12.3	13.9	— 11.5	12.2	4,514	5,106	— 11.6
Oklahoma	503.3	546.7	— 7.9	497.9	174,768	179,361	— 2.6
Pennsylvania	16.2	17.7	— 8.5	16.8	5,751	5,597	+ 2.8
Texas	2,467.7	2,560.0	— 3.6	2,416.3	851,401	900,396	— 5.5
Dist. 1: South Central	45.9	45.9	.....	45.5	14,858	15,161	— 2.0
Dist. 2: Middle Gulf	106.9	112.6	— 5.1	104.3	37,453	39,340	— 4.8
Dist. 3: Upper Gulf	341.3	355.7	— 4.1	332.3	118,113	127,127	— 7.1
Dist. 4: Lower Gulf-S.W.	186.6	180.6	+ 3.3	183.5	62,746	63,705	— 1.5
Dist. 5: East Central	25.5	25.4	+ 0.4	25.3	15,993	9,902	+ 91.8
Dist. 6: Northeast	235.5	244.7	— 3.8	231.3	81,835	87,833	— 6.8
Dist. 7-B: North Central	121.4	126.5	— 4.0	121.2	42,863	51,801	— 17.3
Dist. 7-C: West Central	117.8	122.1	— 3.5	116.7	40,533	42,758	— 5.2
Dist. 8: West	988.0	1,005.7	— 1.8	958.9	336,555	352,209	— 4.5
Dist. 9: North	197.6	203.2	— 2.8	195.6	65,478	68,983	— 5.1
Dist. 10: Panhandle	101.2	107.2	— 5.6	101.7	35,898	35,979	— 0.2
Utah	109.7	105.1	+ 4.4	82.2	34,066	36,581	— 6.9
Virginia	.....	.....	.....	.....	5	6	— 16.7
West Virginia	6.7	5.7	+ 17.5	6.5	2,129	1,987	+ 7.1
Wyoming	366.3	342.2	+ 7.0	362.3	121,541	115,096	+ 5.6
Total, United States	6,971.2	6,981.6	— 0.2	6,822.2	2,344,227	2,351,621	— 0.3

Sources for above 3 tables: Bureau of Mines monthly reports, except last two months based on API and B. of M. weekly reports and WORLD OIL estimates, and Texas Districts from API.

oline stocks may become burdensome and a drag on prices before the end of the winter. This threat will persist through January, February, and March, pending the spring upturn in gasoline demand.

November. Total demand for all oils in November 1960 averaged 9,771,000 barrels daily, a decrease of 273,000 barrels or 2.7 percent from November 1959. The decrease was caused largely by lower fuel oil sales, due to milder weather. Distillate demand of 2,122,000 barrels daily was down 103,000 barrels or 4.6 percent. Residual demand of 1,513,000 bpd was 204,000 barrels or 11.9 percent under November 1959. Gasoline demand, however, was up 74,000 barrels or 1 percent in averaging 3,994,000 bpd. Kerosine demand was up 35,000 barrels or 10.9 percent to 428,000 daily.

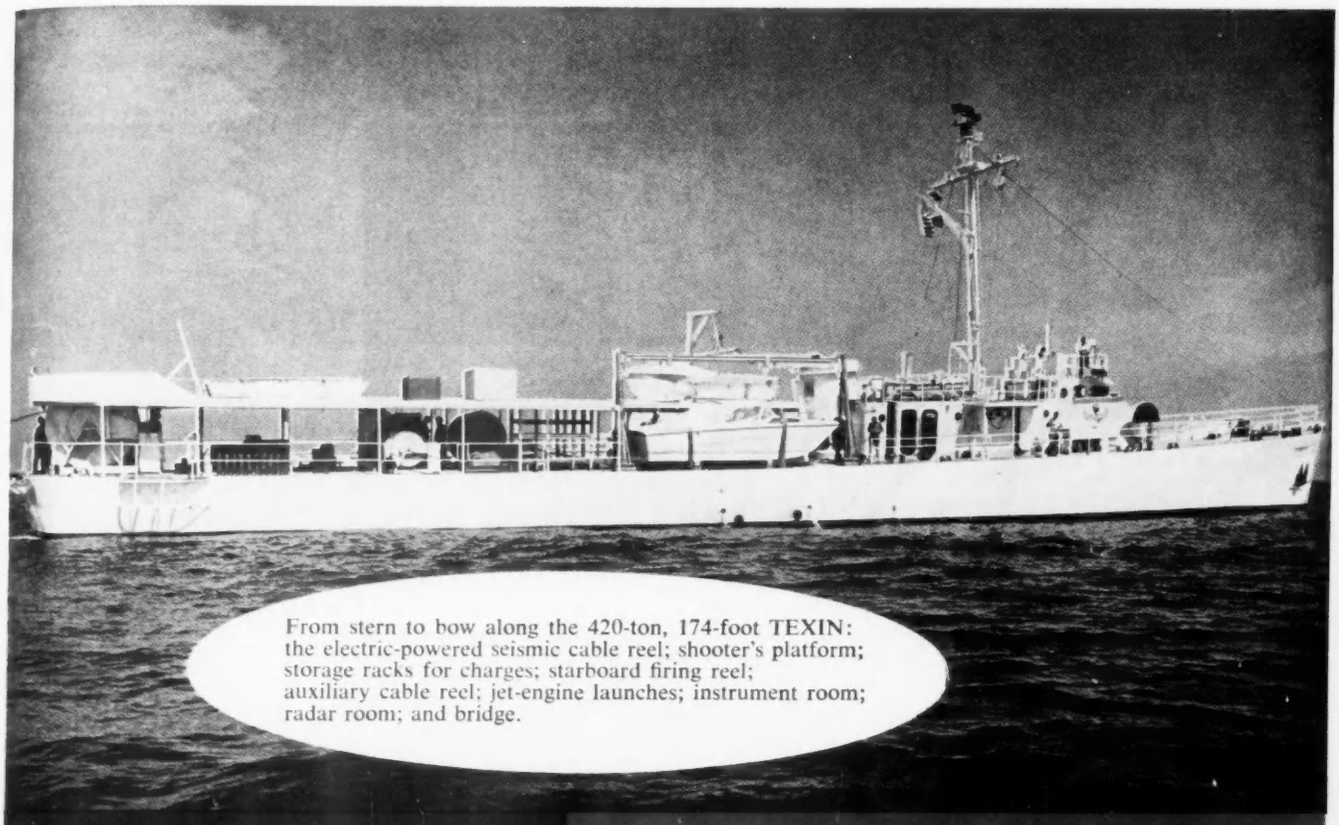
New supply almost equaled demand, as crude production, natural gas liquids output, and imports were stepped up by a total of over 300,000 bpd from October. Consequently, only 23,000 bpd was supplied from storage.

Stocks of all oils at the end of November 1960 totaled 823.2 million barrels. That was 13.3 million less than stocks November 30, 1959. But the decrease is accounted for almost wholly by crude oil, as stocks of most products are above a year ago. Crude stocks of 237.6 million barrels November 30, 1960, were 18.3 million under a year previously and probably were close to minimum requirements.

Gasoline stocks of 187.3 million were 6.3 million or 3.5 percent above a year earlier, though gasoline demand was up only slightly. Distillate fuel oil stocks of 173.1 million barrels November 30, 1960, were 2 million barrels or 1.2 percent above one year previously. Distillate demand showed an increase of 1.4 percent for the first 11 months of 1960.

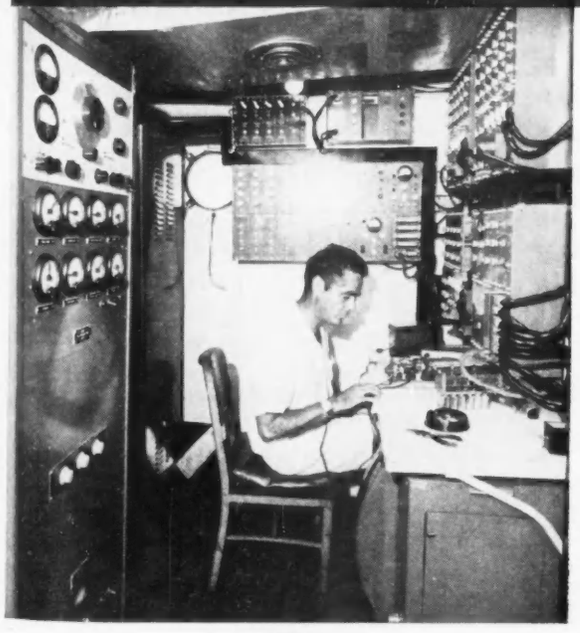
Kerosine stocks of 36.9 million barrels at the end of November 1960 were 6.2 million or 20.2 percent above a year before. But kerosine demand is up sharply because of large use for commercial jet aircraft.

Residual fuel oil stocks totaled 49.3 million barrels at the close of November 1960, down 9.3 million or 15.9 percent from a year before. Residual demand was off 11.9 percent in November but off only 2.2 percent for the first 11 months.



From stern to bow along the 420-ton, 174-foot TEXIN: the electric-powered seismic cable reel; shooter's platform; storage racks for charges; starboard firing reel; auxiliary cable reel; jet-engine launches; instrument room; radar room; and bridge.

EXPLORATION at sea...or in shallow water



Remote coastal areas . . . far distant from supply ports . . . are the scene of many seismic surveys. These areas are best worked with the single-ship method of exploration. GSI's *new* TEXIN, similar to her sister ship the SONIC, travels to your prospect under her own power, arriving equipped and provisioned for an extensive offshore program. Auxiliary, jet-engine launches project data-gathering facilities into water no deeper than 18 inches . . . giving you a complete marine survey . . . from deep water to shoreline.

Write now for Bulletin S 60-1, describing both the TEXIN and SONIC.

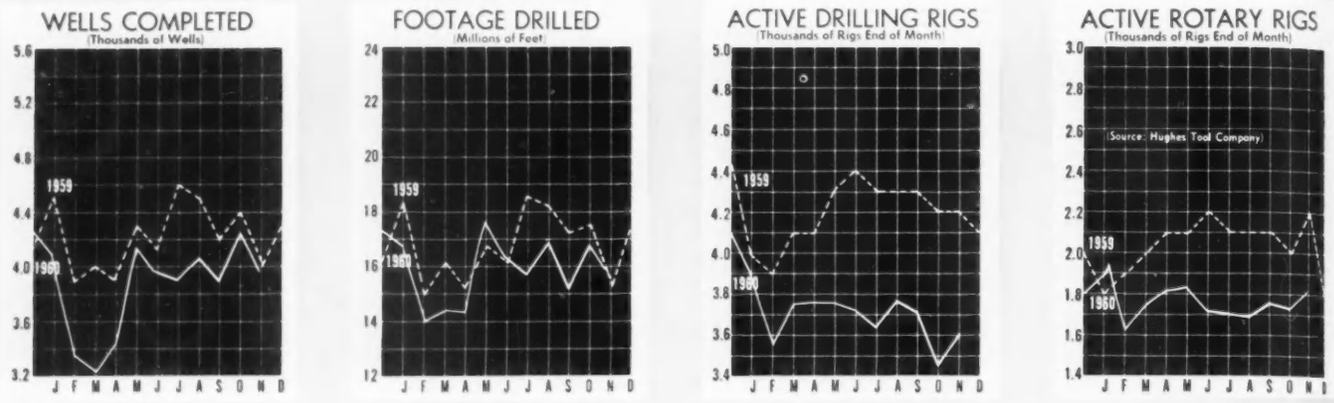
GEOPHYSICAL SERVICE INC.

A TEXAS INSTRUMENTS COMPANY

900 EXCHANGE BANK BLDG. • DALLAS 35, TEXAS

For more data on advertised products, use Readers' Service Cards, last page.

Drilling Activities.


WELLS COMPLETED
(Thousands of Wells)
1959
1960
J F M A M J J A S O N D
FOOTAGE DRILLED
(Millions of Feet)
1959
1960
J F M A M J J A S O N D
ACTIVE DRILLING RIGS
(Thousands of Rigs End of Month)
1959
1960
J F M A M J J A S O N D
ACTIVE ROTARY RIGS
(Thousands of Rigs End of Month)
(Source: Hughes Tool Company)
1959
1960
J F M A M J J A S O N D

November drilling down slightly

By WORLD OIL Staff

THE USUAL seasonal decline in drilling activity during November resulted in:

- **133 new well completions per day,** down 2 wells per day or 1.5 percent from October, and up slightly from nearly 132 wells per day completed during November 1959.
- **3,623 rigs operating on November 30,** down 141 from October's end, and down 362 from November 30, 1959.
- **529,833 feet of hole per day,** down 12,103 feet per day or 2.2 percent from October, and up 3.7 percent from the 510,000 feet per day drilled during November 1959.
- **23 wildcats per day,** compared with 24 per day in October, and 28 per day in November 1959.

Gas and service wells showed the only increases during the first 11 months, with new gas completions up 218 wells or 5.9 percent, and service wells up 114, or 11.2 percent.

New crude oil completions dropped 3,133 wells or 13.4 percent, to 20,307, while distillate completions decreased 30 wells or 4.1 percent, to 703.

Summary of U.S. Drilling Activity

ITEM	November 1960	October 1960	ELEVEN MONTHS JANUARY-NOVEMBER 1960	1959	% Diff.
New Wells Completed:					
Oil	1,898	1,996	20,307	23,440	—13.4
Distillate	45	70	703	733	— 4.1
Gas	406	402	3,933	3,715	+ 5.9
Dry	1,518	1,599	16,599	17,004	— 2.4
Service	130	117	1,135	1,021	+11.2
Total New Wells	**3,997**	**4,184**	**42,667**	**45,913**	**— 7.1**
Footage Drilled (Millions of Feet)	**15.9**	**16.8**	**175.9**	**188.5**	**— 6.7**

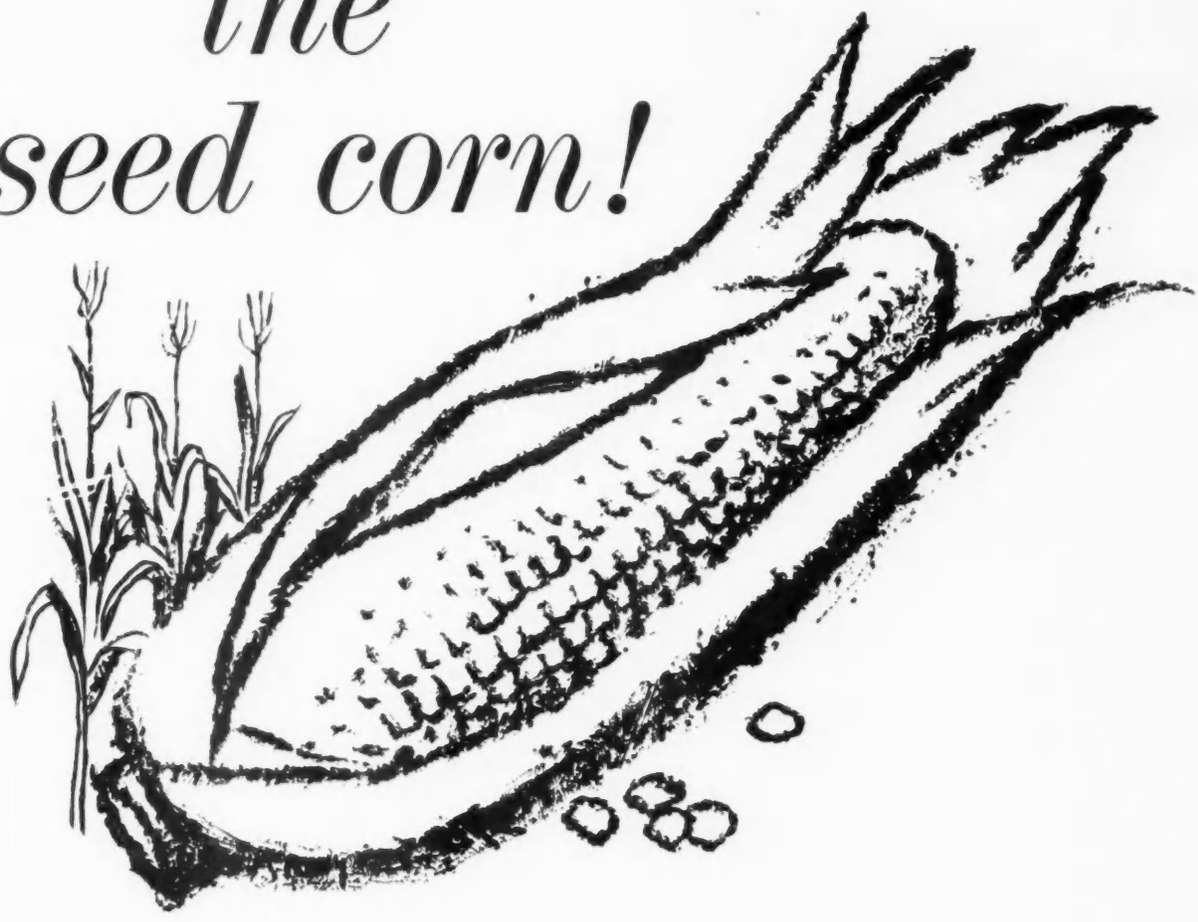
Summary of U.S. Wildcat Drilling

ITEM	November 1960	October 1960	ELEVEN MONTHS JANUARY-NOVEMBER 1960	1959	% Diff.
New Field Discoveries:					
Oil	38	48	500	648	—22.8
Distillate	4	4	63	82	—23.2
Gas	10	19	223	257	—13.2
Total Discoveries	**52**	**71**	**786**	**987**	**—20.4**
Dry Wildcats	**660**	**674**	**7,528**	**8,028**	**— 6.2**
Total Wildcats	**712**	**745**	**8,314**	**9,015**	**— 7.8**
Percent Productive	**7.3**	**9.5**	**9.5**	**10.9**	.....
Percent Dry	**92.7**	**90.5**	**90.5**	**89.1**	.....

Number 1 of a Series

TELL THIS PETROLEUM INDUSTRY FACT TO YOUR NEIGHBOR

Don't eat the seed corn!



From each year's harvest, a portion must be set aside as seed corn to assure a crop next year. Never sold, never eaten, the seed is the only guarantee against a famine.

The same is true with oil and gas. A new "crop" must be *sought* each year. Percentage depletion, commonly but erroneously called "depletion allowance," provides the seed that finances the search and assures next year's crop of oil. A substantial portion of each year's income must be set aside by the petroleum industry, as seed, to guarantee a continuing supply of oil and gas. This operating principle has made the petroleum industry a leader in free world enterprise.

A nation deprives itself of its own future and penalizes all consumers when it deprives any industry of the seed that guarantees future productive harvests.

©COPYRIGHT 1960 BAROID DIVISION NATIONAL LEAD COMPANY

BAROID

BAROID DIVISION NATIONAL LEAD COMPANY

MAIN OFFICE: P. O. BOX 1675, HOUSTON 1, TEXAS

BAROID—*Still Pioneering Drilling Mud Research • Engineering • Marketing*

Production proofs of this message are available. Write Advertising Department, Baroid Division National Lead Company, P. O. Box 1675, Houston 1, Texas. 6099

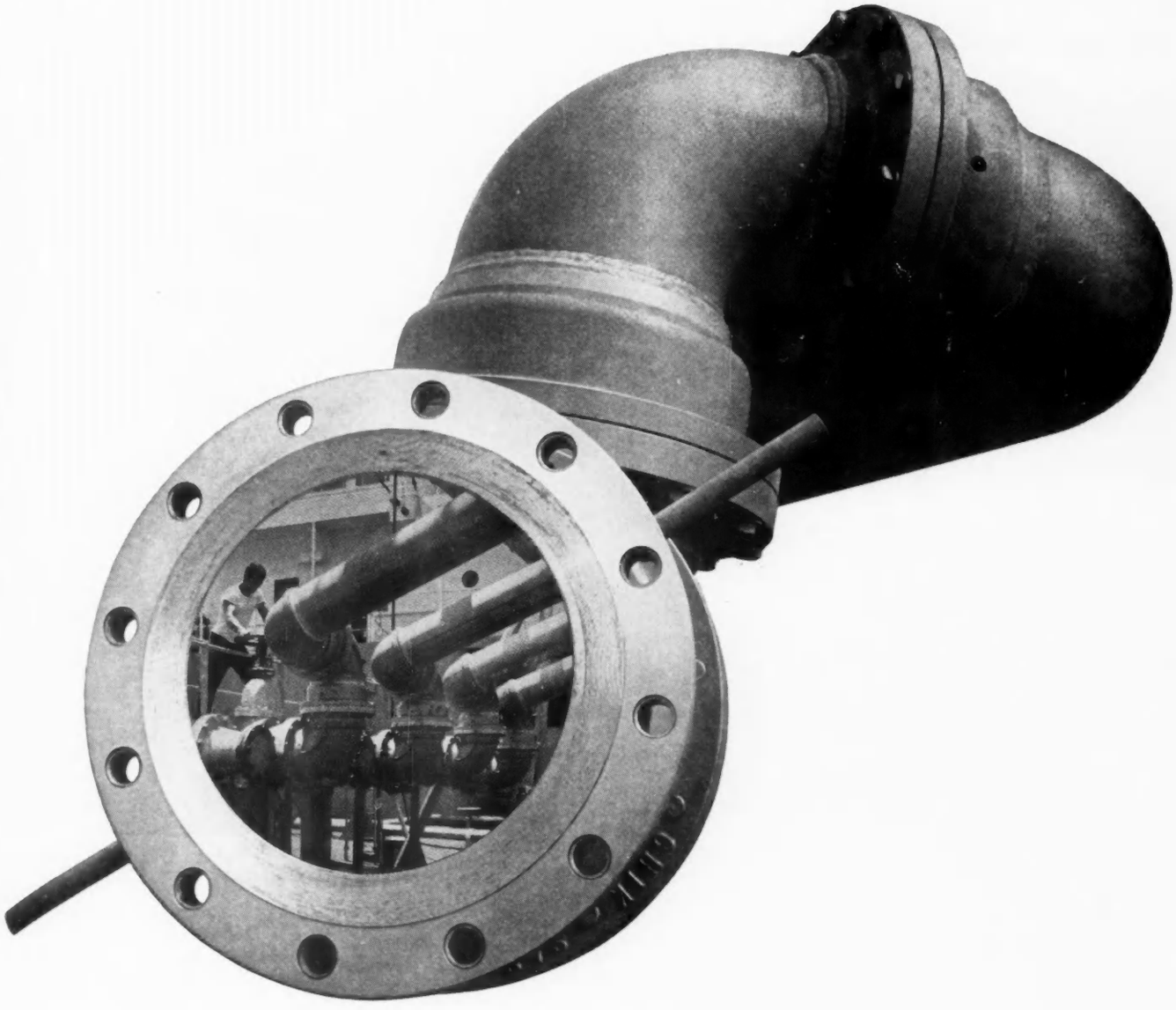
U.S. Drilling Activity in November and First Eleven Months, 1960-1959

STATE or DISTRICT	TOTAL NEW WELLS COMPLETED AND FOOTAGE DRILLED: DETAILS FOR NOVEMBER, 1960 — Oil	Dist.	Gas	Dry	Service Wells	TOTAL NEW WELLS — Nov. 1960	Oct. 1960	Nov. 1959	Total Footage November 1960	DETAILS FOR JANUARY-NOVEMBER — NEW WELLS — 1960	1959	Percent Diff.	FOOTAGE — 1960	1959
Alabama				1		1	9	9	3,541	49	99	— 50.5	452,185	896,448
Alaska	1		1			2	5	2	15,940	20	10	+100.0	199,543	110,485
Arizona				1		1	5	8	1,270	26	30	— 13.3	67,467	86,175
Arkansas	28		3	25		56	59	69	199,515	548	756	— 27.5	1,957,677	2,543,204
California	122		13	37		172	179	143	663,672	1,435	1,351	+ 6.2	6,293,937	6,159,262
Colorado	11		21	50		82	57	28	385,909	605	662	— 8.6	3,071,080	3,385,356
Illinois	53			100		153	223	213	354,201	1,828	1,912	— 4.4	3,894,007	4,238,652
Indiana	26		1	61		88	95	57	125,068	948	794	+ 19.4	1,277,769	1,240,305
Kansas	209		25	215	22	471	420	432	1,653,139	4,563	4,313	+ 5.8	16,030,782	15,401,424
Kentucky	130		23	98		251	274	333	180,870	2,679	3,462	— 22.6	2,123,656	2,894,499
Louisiana	190	17	42	120		369	322	295	2,418,259	3,269	3,472	— 5.9	25,240,752	26,756,989
North Louisiana	86		33	58		177	152	144	518,371	1,283	1,376	— 6.8	4,719,392	4,835,061
South Louisiana	104	17	9	62		192	170	151	1,899,888	1,986	2,096	— 5.3	20,521,360	21,921,928
* Gulf of Mexico	24	1	4	5		34	39	26	344,639	466	423	+ 10.2	4,745,477	4,371,894
Michigan	35		5	41		81	96	66	289,089	781	548	+ 42.5	2,859,688	1,691,714
Mississippi	18		4	27		49	60	45	494,625	629	593	+ 6.1	6,249,807	5,545,887
Missouri				2		2		2	2,398	12	14	— 14.3	29,361	12,901
Montana	13		3	18	1	35	35	25	175,249	285	298	— 4.4	1,398,732	1,434,147
Nebraska	17			56		73	81	36	380,219	861	755	+ 14.0	4,785,022	4,493,143
New Mexico	79		50	26		155	160	196	832,864	1,673	1,652	+ 1.3	8,225,132	6,866,880
Southeast	67		4	1		92	101	102	473,028	1,104	907	+ 21.7	5,589,861	4,225,994
Northwest	12		46	25		63	59	94	359,836	569	745	— 23.6	2,635,271	2,640,886
New York	18		6	2	8	34	34	23	44,210	302	254	+ 18.9	480,660	437,565
North Dakota	8			8		16	21	28	108,513	253	382	— 33.8	1,593,962	2,129,973
Ohio	36		22	34		92	88	132	223,190	938	964	— 2.7	2,294,662	2,476,163
Oklahoma	181	7	33	85	31	337	402	169	1,194,466	4,153	4,855	— 14.5	15,607,012	17,707,087
Pennsylvania	12		16	8	12	48	84	65	147,790	788	633	+ 24.5	2,195,330	1,977,834
South Dakota							2	5		18	20	— 10.0	127,687	142,711
Tennessee				11		11	12	15	12,806	90	107	— 15.9	75,610	100,422
Texas	637	21	77	400	55	1,190	1,247	1,358	4,998,237	13,864	16,194	— 14.4	61,117,083	71,559,138
Dist. 1: South Central	66	1	4	25	1	97	100	84	233,829	1,032	883	+ 16.9	2,648,887	2,304,654
Dist. 2: Middle Gulf	7	5	4	27		43	63	70	325,445	690	737	— 6.4	4,641,050	4,600,526
Dist. 3: Upper Gulf	38	8	4	29		79	86	92	551,727	1,018	1,083	— 6.0	7,301,524	7,734,553
* Gulf of Mexico				1		1		3	6,940	6	5	+ 20.0	55,124	49,112
Dist. 4: Lower Gulf S.W.	22	7	9	37		75	82	75	387,830	948	1,208	— 21.5	5,238,935	6,527,511
* Gulf of Mexico											1			500
Dist. 5: East Central	5		3	12		20	21	15	107,083	197	140	+ 40.7	979,531	750,138
Dist. 6: Northeast	48		4	24	1	77	82	71	393,172	805	763	+ 5.5	4,306,010	4,177,935
Dist. 7-B: North Central	93		11	59	2	165	168	192	500,336	2,011	2,221	— 9.5	5,989,286	7,137,470
Dist. 7-C: West Central	33		2	21	2	58	59	58	256,077	718	698	+ 2.9	2,944,375	3,007,592
Dist. 8: West	165		8	47	15	235	236	322	1,187,935	2,792	4,143	— 32.6	15,553,221	21,270,330
Dist. 9: North	122		7	97	33	259	231	285	680,476	2,621	3,177	— 17.5	6,864,610	8,849,383
Dist. 10: Panhandle	38		21	22	1	82	119	94	374,327	1,032	1,141	— 9.6	4,649,624	5,198,946
Utah	11		1	5		17	17	32	104,765	191	259	— 26.3	1,099,043	1,445,315
Washington				1		1	1		4,697	4	3	+ 33.3	22,069	21,108
West Virginia	13		47	18		78	97	62	196,519	903	713	+ 26.6	2,289,148	1,822,413
Wyoming	50		13	66	1	130	89	95	672,522	935	788	+ 18.7	4,722,029	4,134,058
Others				2		2	10	5	14,248	27	20	+ 35.0	118,980	110,758
Total United States	1,898	45	406	1,518	130	3,997	4,184	3,948	15,897,791	42,677	45,913	— 7.1	175,899,872	188,522,016
Total Western Canada	131		20	52		203	221	223	1,095,784	2,273	2,283	— 0.4	12,426,520	11,402,497

STATE or DISTRICT	WILDCAT DRILLING IN NOVEMBER AND FIRST ELEVEN MONTHS, 1960-1959: DETAILS FOR NOVEMBER, 1960 — Oil	Dist.	Gas	Dry	Total Wildcats	DETAILS FOR JANUARY-NOVEMBER — Oil	Dist.	Gas	Dry	TOTAL WILDCATS — 1960	1959	DRILLING RIGS IN OPERATION (Rigging up, Drilling, Temp. Shut-Down) — Nov. 30, 1960	Oct. 31, 1960	Nov. 30, 1959
Alabama				1	1				8	8	28	7	8	6
Alaska						1		1	6	8	8	8	8	6
Arizona				1	1	1			21	22	29	6	7	2
Arkansas				9	9	3	1	3	104	111	121	43	44	45
California	3			23	26	10		8	250	268	292	139	121	119
Colorado	2			56	58	16		8	270	294	353	67	97	45
Illinois	2			47	49	9		1	589	599	472	267	263	336
Indiana				24	24	5			313	318	222	125	133	94
Kansas	12		1	86	99	83		22	700	805	1,066	242	240	305
Kentucky				1	1	10		1	43	54	81	150	146	200
Louisiana	1	1		40	42	28	14	7	440	489	493	318	312	329
North Louisiana	1			19	20	13		2	196	211	189	67	60	65
South Louisiana		1		21	22	15	14	5	244	278	304	251	252	264
* Gulf of Mexico				3	3		2	1	32	35	34	56	54	48
Michigan				20	20	9		3	216	228	151	112	103	95
Mississippi				19	19	17		1	204	222	222	62	63	86
Missouri				2	2				3	3	11	1	2	2
Montana	2		1	12	15	9		4	107	120	97	24	25	47
Nebraska	1			44	45	25		1	385	411	337	30	22	20
New Mexico	3		2	15	20	55		36	229	320	246	158	146	167
Southeast	3		1	11	15	38		11	171	220	165	93	76	95
Northwest			1	4	5	17		25	58	100	81	65	70	72
New York												25	25	25
North Dakota				6	7	7			59	66	67	12	15	22
Ohio				4	4	3		7	37	47	34	138	126	212
Oklahoma	2			9	11	13	7	31	319	400	680	469	408	466
Pennsylvania			1	3	4			7	18	25	21	50	66	59
South Dakota									8	8	13	1	1	3
Tennessee				4	4	3		3	50	56	57	20	25	30
Texas	6	3	4	216	229	144	40	63	2,772	3,019	3,519	885	776	1,021
Dist. 1: South Central			1	16	17	3	1	3	286	293	279	35	40	35
Dist. 2: Middle Gulf	1			16	17	8	11	7	196	222	260	65	48	48
Dist. 3: Upper Gulf	2	3	1	15	21	9	16	5	232	262	260	90	82	106
* Gulf of Mexico									3	3	4	1	2	
Dist. 4: Lower Gulf S.W.			2	24	26	10	9	15	276	310	374	85	72	74
* Gulf of Mexico											1			
Dist. 5: East Central				7	7	2	1	4	99	106	62	16	13	15
Dist. 6: Northeast	1			15	16	6	2	3	157	168	162	76	54	59
Dist. 7-B: North Central	1			32	33	43		10	546	599	725	84	77	100
Dist. 7-C: West Central				13	13	15		6	188	209	232	67	73	68
Dist. 8: West	1			32	33	36		5	323	364	515	175	145	287
Dist. 9: North				37	37	12		1	396	409	507	127	113	146
Dist. 10: Panhandle				9	9			4	73	77	143	65	59	83
Utah			1	4	5	2		8	62	72	73	34	38	28
Washington				1	1				3	3	3	1	1	1
West Virginia											1	156	194	124
Wyoming	3			31	34	17	1	8	287	313	304	63	58	85
Others				2	2				25	25	14	10	9	5
Total United States	38	4	10	660	712	509	63	223	7,528	8,314	9,015	3,623	3,482	3,985
Total Western Canada												160	157	193

* Gulf of Mexico wells are included in their respective district totals.

CHIKS. FMC



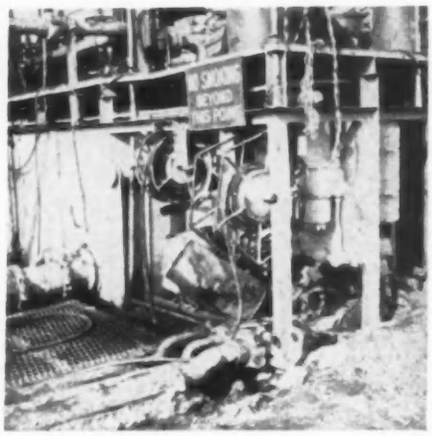
THIS IS THE BEST WAY TO LOAD TANKERS–
And the heart of this system is the swivel joint. Produced by a company with 30 years of experience in solving flexible line problems. Proven by hundreds of installations around the world on Chiksan's Hydraulic Marine Loading Systems and other dockside loading lines. Recommended and preferred for safety and long life by responsible men everywhere. It is a **CHIKSAN** Swivel Joint.

fmc

CHIKSAN COMPANY—General Offices: Brea, California • Well Equipment Mfg. Corp. Division (Weco Unions, Hamer Valves) • Chiksan International • Chiksan of Canada Ltd.
Offices and Representatives in Principal Cities of the World

Practical Operating Hints

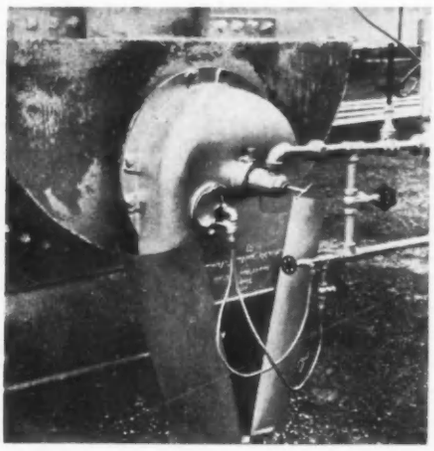
These How-To-Do-It Ideas Can Save You Money



Sucker Rods Used As Storage Reels for Hoses

To protect hoses in use on the rigs and to keep down maintenance expense, proper storage should be provided for hoses so that they will not be cut or damaged while working around the rig.

One operator has fabricated reels out of discarded sucker rods and mounted them in brackets near his mud mixing tank. The center sections of the reels are made from 5 and 7-inch diameter casing and are hand operated. The reels provide a handy storage for the water and air hoses and also for trouble light cables. The hoses can be unreeled readily when they are needed and can be reeled up for storage when the crew is finished with them.



Prevent Line Heater From Blowing Out

Occasionally operators have difficulty in keeping line heaters fired in windy weather. The problem has been solved in this case by placing two pieces of tin on each side of the fire box. The heater remains in service and hydrate formation in the flow line is prevented.

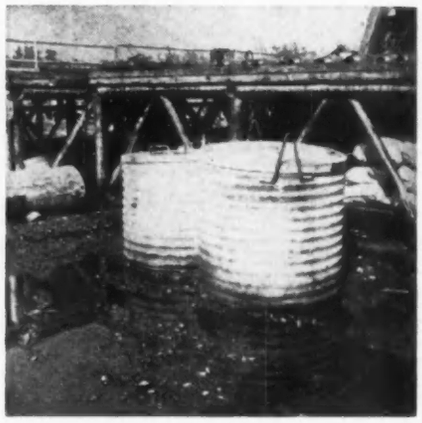
Pipe Tong Counterweight Installed on 'A' Frame

Here is a convenient out-of-the-way place for installation of tong counterweights. This servicing contractor installed them on the A frame which supports the mast while the unit is on the move. The springs on the rig proper which can not be adjusted for different tong weights may be removed. The sliding weights on the front of the truck can be closely adjusted to any desired weight. When the mast is laid down, the wireline is wrapped up with the guy wires.

Metal Pin Lets Driller Observe Level of Mud Pit

The level of the mud of the pit should be known at all times. Here is shown a means of using a metal pin which is dropped through the grating over the settling pit to show the driller any changes in the mud level.

The head of the pin is large enough to keep it from falling into the pit. As the mud approaches the pin and continues to rise, the pin will also rise and protrude above the wire mesh. This indicates to the driller that an unusual condition of the circulatory system is present.



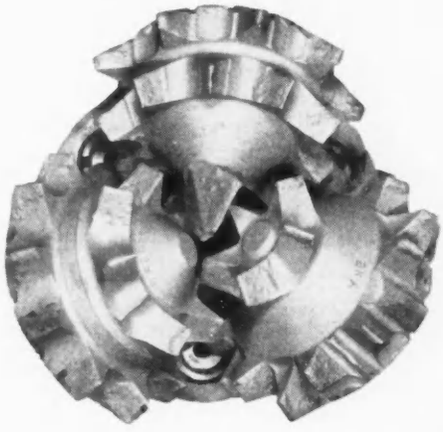
Make Handy Tool Carriers Out of Corrugated Pipe

There is always an abundance of small parts and connections that must be carried around a rig to facilitate rigging up water lines, mud lines, gas lines, etc. Every contractor has his own ingenious method of keeping these parts together.

One contractor welded a bottom onto a four foot length of 40-inch corrugated pipe and fashioned lids to fit. Handles for the lids were welded on and pick up bails were welded to the side of the pipe. All manner of rig supplies could be transported in these carriers. They could be placed at any convenient location at the rig site and when moving the rig they can be picked up easily with a gin pole and set on a truck, or on short moves moved with the gin pole.

Make Speed Reducer From Scrap Material

This operator was having trouble keeping air cooled engine powered pumping units running at the proper speed. To correct the problem, a re-



Smith TYPE DT ROCK BITS

FOR SOFT FORMATIONS

The SMITH TYPE DT 3-cutter rock bit is designed and constructed to insure rapid rates of penetration in moderately soft to soft formations...sturdy, deeply cut and widely-spaced teeth...optimum self-cleaning properties are provided by the widely-spaced teeth in combination with ample tooth deletions and efficient flushing action of the circulating fluid.

Smith TOOL CO.

A division of SMITH INDUSTRIES International Inc.

COMPTON, CALIFORNIA

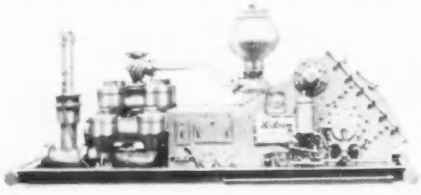
Branches in Principal Oil Centers Throughout the World

1936 OUR 25th YEAR 1961

DRILL MUCH FASTER

and eliminate expensive repair bills! . . . with

WILSON GIANT SLUSH PUMP



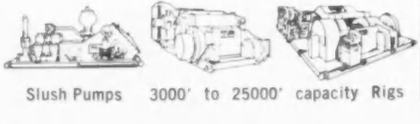
• Chain Drive • Light Weight • High Speed • Fabricated Plate Steel Case • Can be used efficiently on any work from 300 to 600 Horsepower • Lightest Weight, only 33 pounds per horsepower

Wilson

WILSON MFG. CO., INC.

Wichita Falls, Texas • The Home of RED IRON

Winchmobiles Traveling Blocks Speedwinches



Slush Pumps 3000' to 25000' capacity Rigs

ducer was built from scrap and installed as shown. A front spindle and brake-drum assembly from an old automobile was purchased for $2.50. Everything except the bare spindle and hub was removed and a piece of 1-inch pipe was welded to the end of the spindle and to an old fabricated slide rail. Two gussetts were welded along the 1-inch pipe for strength. In this case, the O.D. of brake drum was 12-inches.

A 4.6-inch P.D. three-belt sheave was welded to the outside of the hub. The engine sheave is 3.5 inches and the unit sheave is 16 inches P.D. With a 29.1-1 gear box ratio, this allows the engine to run fast enough to cool and lubricate properly. No difficulties have been encountered once the speed reducer has been installed. The old fabricated slide rail on which the reducer is mounted is clamped to the unit frame and is easily installed or removed without defacing the unit.

Carry Drill Pipe in Bundles To Facilitate Moving

Handling of drill pipe can be simplified by using the enclosed bundle carrying device.

When the hole is completed, the drill pipe is laid down and rolled off into bins. When the bin is full the pipe is sucked up on a truck and spotted beside the catwalk on the next location. On the new location, pipe is picked up from the racks and put into the hole. It is not necessary to roll the pipe or handle it except into and out of the hole.

"I've ALWAYS preferred KING GA SWIVELS"

King Swivels 32GA and 53GA have been popular for many years. They have proved to be rugged, dependable and durable, and are in use around the world because they are "preferred". The fact that King Oil Tools is the largest manufacturer of lightweight swivels is supporting evidence of King engineering, service efficiency and complete all-around dependability.

INDUSTRY RECOGNIZES KING GA SWIVELS BY THESE FAMOUS FEATURES:

- ALLOY STEELS assure strength with minimum weight.
- PACKING is V-type, often called chevron type.
- WASHPIPES are seamless alloy tubes, case-hardened and ground.
- GREASE LUBRICATION for the packing.
- MULTIPLE BALL BEARING UNITS provide ample capacity.
- OIL BATH LUBRICATION for the bearings.
- Choice of BAIL OR ELEVATOR SHANK.

FOR FULL INFORMATION ON ALL KING SWIVELS — SEE YOUR NEAREST DISTRIBUTOR — OR WRITE:

KING OIL TOOLS

P. O. BOX 15146 • HOUSTON 20, TEXAS • ORchard 3-3421

WORLD OIL
January 1961

A special report on . . .

NORTH AFRICA

One of the world's most desolate regions has become a major oil and gas producer

FIVE YEARS AGO, North Africa's oil and gas reserves were yet to be tapped. Less than 50 rigs drilled only 750,000 feet of hole on the entire continent during 1955, with crude oil production averaging less than 35,000 barrels per day.

Then came the big 1956 Algerian Sahara strikes, including the now famous Hassi Messaoud field. These discoveries resulted in the first shipments of crude oil from French Equatorial Africa to France—and the beginning of a huge new oil and gas frontier.

From 1956 on, North African oil and gas statistics are legend. Activity looks like this for 1960:

- **Rigs operating**—106, with more than 80 in Algeria and Libya alone.
- **Footage**—2,263,000 feet.
- **Well completions**—358, up 40 percent from 1959.
- **Crude oil production**—165,000 barrels per day, nearly all of which is in Algeria. Estimates are that Algerian production will increase to 520,000 or 625,000 barrels per day by 1965.
- **Reserves**—More than 6 billion barrels of recoverable crude oil reserves have been proved to date, with nearly 1.5 billion barrels in Algeria's Hassi Messaoud field out of a possible 20 billion in place. Gas reserves in Algeria's Hassi R' Mel field alone are estimated at 35-70 trillion cubic feet. Libya's reserves are expected to be comparable to Algeria's totals.

This five-year transformation of one of the world's most desolate regions into a major oil and gas producer is a tribute to French persistence and technical know-how. In fact, it can conservatively be termed one of the significant technical achievements during the post war era.

However, two major obstacles remain—transportation and marketing. Rapid strides are being made to solve these problems. A

AFRICAN DESERT, with deep sand and excessive heat and distances, presents a real challenge to both men and equipment.

large diameter crude oil line has been laid from the Hassi Messaoud field to the Mediterranean coast at Bougie. Another has been completed from Edjele in eastern Algeria to La Skhirra in Tunisia.

Hassi R' Mel gas field discovery has led to tentative plans to lay four 8-inch gas lines across the Mediterranean (in depths to 10,000 feet) to Western Europe via Spain, and to liquefy methane for international shipment.

The push on the part of the Russians to build large oil pipe lines to Western Europe consumption centers has spurred France to establish Sahara oil and gas markets in Europe at the earliest possible date.

WORLD OIL ON-THE-SCENE COVERAGE

Rapid development of North Africa into a major oil and gas area despite its formidable natural barriers has sparked the interest of the entire world.

To bring the oil and gas industries of all nations up to date on this important technological achievement, WORLD OIL commissioned Joseph Kornfeld, internationally known geologist, to visit North Africa to obtain an on-the-scene report. His efforts, plus the results of extensive WORLD OIL research, are represented on the following pages.

MAP SHOWS LATEST DEVELOPMENTS

Also included in this issue is a 40 x 28-inch insert map showing the latest oil and gas developments in North Africa. Additional copies of this map are available at $1 each. Use the Readers' Service postcard at the back of this issue to place your order.

Joseph A. Kornfeld received his undergraduate and graduate degrees in geology from Texas Christian University. In 1946 he did post-graduate work in reservoir engineering at The University of Texas. He is the author of more than 100 articles on petroleum geology, geophysics, secondary recovery, and reservoir engineering on the Gulf Coast, Rocky Mountain, Mid-Continent and Illinois basin provinces. Kornfeld participated in the Fifth National Clay Conference at Urbana, Ill., in 1956, and addressed the twentieth session of the International Geological Congress in Mexico City that same year. Last September, he presented a paper on "Optical Properties of Emulsions" at the Third International Congress on Surface Activity in Cologne, Germany. Kornfeld is affiliated with the Society of Exploration Geophysicists, Society of Economic Paleontologists and Mineralogists, American Chemical Society, American Geophysical Union, Geochemical Society, Tulsa Geological Society, AIMME, and the Engineers Club of Tulsa.

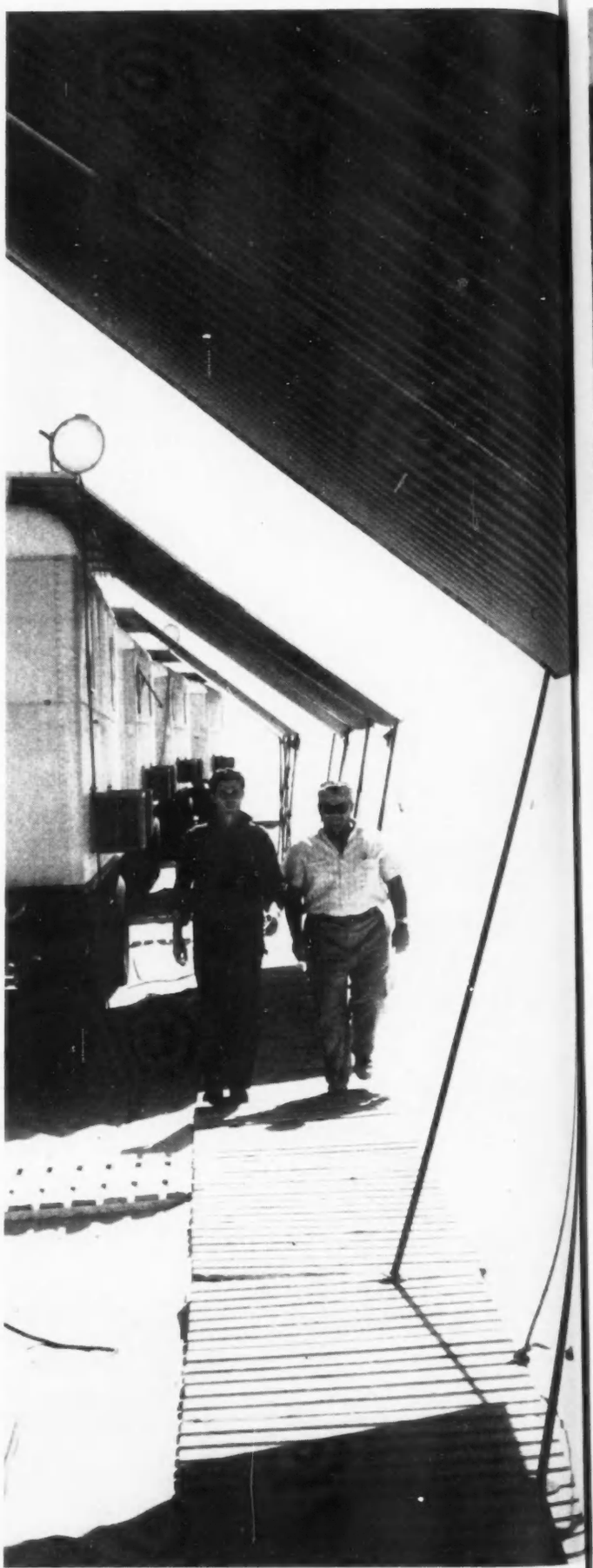


Photo courtesy Standard Oil Company (New Jersey)
Modern truck trailers with air conditioning units provide suitable housing in the Zelten field of interior Libya.

Photo courtesy S. N. Repal

Hassi Er R'Mel employes' camp at the locale of the largest natural gas reserve in the French Sahara.

. . . So you're going to North Africa

There will be abundant social life and relaxation, normal living conditions and a fatter bank account

By Joseph A. Kornfeld
President, Kornfeld International, Tulsa

YOUR INTRODUCTION to the Dark Continent as an oil company employe can be an exciting adventure. You will be transformed into the setting, history and mysteries of Africa and the Moslem world. You will see the ruins of seven ancient civilizations in the fascinating region which dates back to the Phoenicians who migrated there in their primitive sailboats during the 11th century B. C.

TUNISIA

You arrive at the Tunis Municipal Airport only a few hours away from your European departure point. A panorama of ancient Roman ruins will unfold during the taxi ride to a modern Tunis hotel. Famed Carthage once challenged the might of the Roman Empire only a few miles from Tunis.

But, what about the practical problems of living in North Africa?

Housing. Many expatriates live about 12½ miles from Tunis and commute to offices in the city. Villas are obtainable in the suburbs. City dwellers (especially bachelors) live in 3-room apartments comprised of a living room, dining room, kitchen and bath. Apartment rent

is about 100 percent higher than in large U.S. cities, depending upon location, size and quality.

Rentals are issued on a minimum contract of one year and advance rentals are paid for periods of from three to six months. Before vacating the premises, one must pay three months rental in advance.

Little central heating is available. The climate is humid in the winter and the temperature rarely falls below 40°F. Portable heating units may be installed by landowners.

Schools. Tunisian schools, modeled after the French system, are operated by the state with facilities for 12 years of schooling up to university level.

Arabic is a required language in the public schools even though other subjects are taught in French. An American school is in operation in Tunis.

Food. All fruits are available in season. Tropical fruits include an abundance of citrus, grapes, dates, olives, melons, peaches and pears.

Although there are no supermarkets, there are ample grocery stores scattered throughout the city and its suburbs. Food prices are reasonable.

Entertainment. For relaxation and diversion, there are golf courses, tennis courts, sea-fishing, boating and hunting for wild boar and birds. Amateur archeologists have plenty of space and ruins to explore throughout all of North Africa.

Dining-out is a pleasure in the various European restaurants and in the hotel dining rooms overlooking the boulevards.

Clothing. Clothing is similar to that in southern California and south Texas. There are many modern stores exhibiting European styles, but costs are considerably higher than in the States.

Transportation. Ample transportation facilities are available in Tunis. Taxi service is excellent and prices are moderate. Modern buses and electric railways also are available.

Taxes. For a married man earning less than $500 per month, the state income tax is slightly less than in the States; above that salary figure, the tax rate rises sharply.

Servants. Despite current unemployment, a shortage of trained servants exists throughout Tunisia.

ALGERIA

Most oil company employes headquartered in Algiers, live about 16 miles from the heart of the city and commute by car. In the 10 p.m. curfew zone, an 8-room house rents for $140 per month; for those homes in the 1 a.m. curfew zone (better police protection) rentals are double that price.

Domestic servants are available at a base wage scale of $64 per month.

Entertainment. Dinner parties usually are set for 8 p.m. and for those people living in the 10 p.m. curfew zone, all guests must depart before that time. Due to the rebel activity, it is unsafe to travel outside the city after sundown.

Recreational facilities include sailing and boating in the beautiful Port of Tunis. Tennis courts and swimming pools dot the city.

Shopping. The European-style stores that line Rue Michelet, the principal street in this port city of 520,000, abound with many of the finest retail stores in the entire Mediterranean region. Shopping facilities are as plentiful though most visitors find clothing prices prevail at substantially higher levels than at home.

LIBYA

Libya has taken on the aspect of an oil boom since the discovery of Zelten.

Oil exploration and production men make their homes in Tripoli, the capital and chief city which lies on a small bay of the Mediterranean Sea, almost 100 miles from the northwestern border of Libya. It is an important trading center and has a protected harbor. The climate is tempered by breezes from the Mediterranean Sea.

In the interior, even with air-conditioned trailers and frozen goods, a somewhat harsh environment is encountered. One of the hottest places on earth is at Azizia, only two hours from the coast, where the temperature rises to as high as 135° F.

Almost three times the size of Texas, Libya's expanse is 90 percent desert, with an occasional oasis. However, along the Mediterranean coast, the land is tillable and supports crops of grains, fruits and olives.

Customs. A U.S. oil company employe working in Libya is faced with the constant problem of understanding the customs of the Moslem world. In Libya, it is the men who go to market, who take the children to the doctor and do all the tasks outside the home.

MOROCCO

The Sahara occupies less space in Morocco than the towering Atlas Mountains, the fertile northern plain and the rich littoral areas. The Arabs call it Maghreb el Aksa —the Land Farthest West.

Casablanca, the capital city of Morocco, is characterized by its modern, severe and functional architecture. Like Algiers, white skyscrapers punctuate the blue skyline. Its harbor is hidden behind the cranes and warehouses of one of Africa's busiest ports.

Here is a melting pot where Africa and Europe have been fused with more than 700,000 inhabitants of various extractions. "The City of the White House," Casablanca, has had a phenomenal growth. Less than a half-century ago there were only 20,000 residents.

Oil base. French engineers employed by Societe Cherifienne des Petroles the principal oil-producing firm in Morocco, commute by jet plane between the principal operating office located at Rabat (50 miles northeast of Casablanca) and the general administration office in Paris.

NIGERIA

Africa's newest and most populous nation (35 million people), is the locale of the latest major oil boom on the continent. The capital is located in the southwestern coast of the country, in sweltering Lagos.

However, the center of oil activity lies at Port Harcourt at the head of Bonny River, in one of the heaviest rain forests of the world. It is a land of exceptionally high humidity with an annual rainfall of from 120 to 140 inches. This is the administrative center. Four helicopters carry supervisory personnel between this operating and headquarters base to the oil fields radiating to the east and west.

Photo Courtesy S. N. Repal

Hassi Messaoud employes live at Camp Irara in heart of French Sahara near the largest crude oil reserve in North Africa.

The Sahara – largest and most arid desert in the world

Sand dunes rise 450 feet, rainfall averages less than 4 inches per year, temperatures range from 0 to 175 degrees

COMPRISING THE LARGEST and most arid desert in the world, the Sahara extends about 3,200 miles from west to east of Latitude 20° N. The width varies from 800 to 1,400 miles.

The total area of the Sahara, aggregating more than 3,500,000 square miles, is greater than that of the continental United States and Alaska; about 1,660,000 square miles represent a portion of the French Community.

Three divisions. Geographically, the Sahara may be divided into three major divisions. First, the western Sahara which contains rock strewn plains and sand deserts of various elevations. The central region is the Tuareg Plateau which is underlain by a number of underground rivers which flow from the Atlas Mountains and the mountains of the Tuareg Plateau. The third division is the Libyan Desert which lies in the east.

The Tuareg central plateau region extends in a northwesterly to southeasterly direction for more than 1,000 miles. Although the tableland ranges from 1,900 to 2,500 feet in height, the peaks which rise from the Tuareg in the numerous mountain ranges extend from 6,000 to 9,800 feet above mean sea level.

Although the Sahara is almost entirely without surface water or rainfall, the water from the underground rivers reach the surface through natural springs and dug wells. Oases flourish in the naturally irrigates areas. The high fertility of the soil permits raising of crops in those localities where irrigation is feasible.

The most arid portion of the Sahara is the Libyan Desert. Few oases exist there and moisture is practically absent. Sand dunes rise to heights of more than 450 feet above the desert.

Generally, the Sahara tableland has an average elevation of between 1,300 and 1,600 feet. The rainfall is very irregular and averages less than four inches per year.

A wide range of temperatures feature Sahara geography. In the western and central portions, the temperature ranges below freezing to over 130° F (54.4° C) in the same region. Very high surface-soil temperatures have been recorded in Libya, up to 175° F (79.4° C).

Generally, there is little vegetation in the Sahara although some thorny shrubs are found in the western Sahara. The acacia and the date palm are the chief trees found among the oases.

Major topographic features. The Atlas Mountains form one of the major topographic features of North Africa and the western Sahara. This irregular mountain mass extends for a distance of 1,400 miles in a southwesterly to northeasterly direction. It ranges from Cape Nun in Morocco into Cape Bon which lies on the extreme northeastern tip of Tunisia.

Mountain slopes are covered with wild olive, white popular, oak and pine. The fertile valleys support cereal crops, the principal agricultural resource.

Three topographic zones may be found in Algeria. The Tell lying in the northeast, comprises a hilly region which extends inland from the Mediterranean Sea for 50 to 100 miles. This is the most arable section of Algeria and supports the greatest concentration of population which ranges from 50 to 322 persons per square kilometer. This is the locale of the demographic paradox of Algeria, the overpopulation of Kabylia, as the Tell region is often called.

The second zone contains ranges and spurs of the Atlas Mountains which lie south of the Tell and extend into the northwest. Precipitation ranges between 20 and 40 inches per year in the Tell on the northern slopes of the uplands.

The Sahara Desert, the third zone of Algeria, comprises an area in Algeria, more than ten times greater than the other two zones combined.

Significant Facts About Major North African Countries

Country	Date of Independence or Governing Country	Area (1,000 sq. km.)	Population (1,000s)	Capital City	MONETARY STANDARD	
					Designation	Parity
Cameroon	1960	432	3,400	Yaounde	fr. C.F.A.[1]	1.77
Ivory Coast	1960	323	3,090	Abidjan	fr. C.F.A.[1]	1.77
Dahomey	1960	116	1,730	Porto Novo	fr. C.F.A.[1]	1.77
Ghana	1957	238	4,910	Accra	Ghanian pound	12.24[2]
Guinea	1958	246	2,600	Conacry	French Guinea	1.77
Upper Volta	1960	274	3,740	Ouagadougou	fr. C.F.A.[1]	1.77
Liberia	1847	111	1,700	Monrovia	Liberian dollar	4.37[2]
Libya	1951	1760	1,150	Bengazi/Tripoli	Libyan pound	12.24[2]
Mali	1960	1204	3,700	Bamako	fr. C.F.A.[1]	1.77
Morocco	1956	450	10,550	Rabat	dirham	—.86[2]
Mauritania	1960	1085	650	Nouakchott	fr. C.F.A.[1]	1.77
Niger	1960	1189	2,500	Niamey	fr. C.F.A.[1]	1.77
Nigeria	1960	879	34,000	Lagos	Nigerian pound	12.24[2]
Central African Republic	1960	617	1,160	Bangui	fr. C.F.A.[1]	1.77
Senegal	1960	197	2,300	Dakar	fr. C.F.A.[1]	1.77
Somalia	1960	638	1,980	Mogadiscio	somalo	—.61[2]
Sudan	1956	2505	11,500	Khartoum	Sudanese pound	12.56[2]
Chad	1960	1284	2,600	Fort-Lamy	fr. C.F.A.[1]	1.77
Togo	1960	57	1,100	Lome	fr. C.F.A.[1]	1.77
Tunisia	1956	125	3,900	Tunis	Tunisian dinar	10.33[2]
Algeria	France	209	9,800	Alger	New Francs	88.57
British Cameroon	England	88	1,600	Bouea	Nigerian pound	12.24[2]
Gambia	England	10	290	Bathurst	East African pound	12.24[2]
Spanish Guinea	Spain	28	220	Santa Isabel	peseta	7.29
Portugese Guinea	Portugal	36	565	Bissau	Guinean Escudo	15.09
Spanish Sahara	Spain	450	50	Villa Cisneros	peseta	7.29
Sierra Leone	England	72	2,260	Freetown	East African pound	12.24[2]
French Somaliland	France	22	70	Djibouti	Djibouti Franc	2.04

[1] French African Colonies Franc.

[2] Signifies that the parity corresponds to a single monetary unit; in terms of the French franc; otherwise, the currency applies to 100 units. The exchange rate for the "escudo" of Portugese Guinea is quoted as of October 1, 1960.

A limited number of extra copies of the Oil Developments Map of North Africa, inserted in this issue of WORLD OIL, are available at $1 each. Maps can be ordered by using the Readers' Service Card at the back of this issue.

Panorama of Las Palmas, seacoast metropolis lying on the northeastern coast of Grand Canary Island, 120 miles off the coast of the Spanish Sahara. More than 110 oil company families have moved here in the past year, employed by geophysical and drilling contractors working on the mainland, in the newest exploration campaign in North Africa.

Las Palmas, West Africa's offshore operating base, is booming

More than 110 oil company families moved to this beautiful and historic city during the past year

LAS PALMAS, port and chief metropolitan city of the Canary Islands, is the offshore operating base for the mainland of Africa's northwest coast, particularly the Spanish Sahara.

This newest boom city on the North African oil scene, with a 1950 census of 153,262, has more than a third of the population of the 1,565 square-mile Las Palmas Province. Since January 1960, 110 oil company families have moved there. And the influx of oil firms is continuing.

Tidewater Oil Company moved to Las Palmas early in 1960, followed by Union Oil Company of California. Then, Falcon Seaboard Drilling Company opened its first office for the Eastern Hemisphere.

Oil companies selected this city for its excellent seaport and shipping facilities. Moreover, there were no seaport facilities on the Spanish Sahara coast suitable for unloading drilling rigs and geophysical equipment.

Although 120 miles from the mainland, this well-established port offered the oil industry the practical answer to the important problem of logistics.

Oil boom brings change. The new oil economy is the latest in a series of significant economic changes which

have swept these islands during the past century.

The wine economy, upon which these lands were largely dependent since their conquest by the Spaniards in 1496, was wiped out by a grape blight which destroyed the vineyards during the 1850s.

However, the area rapidly recuperated economically with the ensuing permanent boom brought about by importation of the Chinese banana tree. In 1930, irrigated land activity pushed values up to $15,000 an acre.

Five climatic zones. The combined archipelago, with a population of 825,000 and known as the Canary Islands or Canaries, lies from 60 to 300 miles off Northwest Africa at about 30° latitude north and 15° longitude west.

Five climatic zones range from sea level to the snow-capped 12,162-foot Teide peak on the island of Tenerife, which rises to a greater height than any island mass found in either the North or South Atlantic Ocean.

Group of volcanic islands. Las Palmas, lying at the northeastern corner of Grand Canary, is the most beautiful of the Canaries. There, in the greenest of the archipelago, heavy pine forests, waterfalls and volcanoes abound. In the island's center lies the famous Taburiente caldera, an enormous extinct volcano three miles in diameter and one mile in depth.

Widespread exploration for oil and gas underway in new French Community

Major companies are moving fast in the newly emergent North African nations

THE NEW FRENCH COMMUNITY, created by Referendum two years ago, is destined to exert a major impact on exploration policies covering oil and gas throughout a vast region of North Africa.

Included in the Community are the French Republic and its former overseas territories of Equatorial Africa, West Africa and Madagascar. (See table for countries involved). The form of the Community is about midway between a federation and a confederation, comprising 85 million people scattered over 4 million square miles.

Fundamental principles. In accordance with the Constitution of 1958, the principles of the Community are:

- Common citizenship.
- Equality of rights and duties of all citizens, without any racial or religious discrimination.
- Complete solidarity of the member states.
- Full internal autonomy of the member states to determine their own institutions, which are to function without French authority.

Extensive oil search. The search for oil and gas in the French Community has been spurred on by the major reserves found deep in the French Sahara at Hassi Messaoud, Hassi er R'mel, Hassi el Gassi-Erg-El-Agreb and the major fields of the Fort Polignac Basin.

Exploration is being conducted in many of the newly emergent North African nations for the first time. Exploitation continues in Senegal, already an oil-producing nation.

Exploratory drilling is underway in the Ivory Coast Republic, a state the size of New Mexico. Geological and/or geophysical operations are in progress in the Republic of the Niger and the Islamic Republic of Mauritania.

Exploration permits have been granted in the Republic of Dahomey and others are being applied for over a geographic area larger than the United States. (See Table 1).

The economic impact of this far-flung exploration campaign will not be felt on world markets for several years. In some areas, reconnaissance is under way with surface geological parties, air-borne magnetometer, refraction seismograph, mapping of great massifs and studies of the ages of pre-Cambrian rocks by radioactive carbon dating.

In other areas, exploration has proceeded in known coastal basins in the Tertiary and Cretaceous systems with only a handful of deep tests drilled to date in pioneer exploratory drilling.

Also, the offshore chapter is just starting along the Gold Coast, with great potential in the offing.

TABLE 1—North African members of the new Franco-African Community

(Arranged in decreasing order of population)

Republic	Capital	Area Sq. Miles	Population
Mali[3]	Bamako	463,500	3,700,000
Upper Volta[1]	Ougadougou	106,000	3,500,000
Ivory Coast[2]	Abidjan	127,520	3,000,000
Chad[3]	Fort-Lamy	501,000	2,730,000
Niger[3]	Niamey	490,000	2,600,000
Senegal[1]	Dakar	76,084	2,260,000
Dahomey[4]	Porto-Novo	44,290	1,720,000
Central African Republic	Bangui	238,000	1,130,000
Mauritania[3]	Nouakchott	418,120	620,000

Oil Status.
[1] Oil productive. [2] Exploratory drilling in progress. [3] Exploration work in progress. [4] Exploration permits granted.

New door-to-door service eases problems of moving overseas

Here's an informative report on latest advancements, plus valuable tips on insurance and broker selections

WHAT'S NEW in overseas moving? Probably the single biggest step forward is the development of international door-to-door service.

Under this new service, a family's possessions are moved from the origin residence to the destination residence on one through bill of lading, thus providing single, undivided responsibility. Most Americans are familiar with shipping various commodities, including household goods, within the United States under one bill of lading. This was practically impossible with international shipping under the old method of overseas moving.

The new international "door to door" mover is responsible for loading in origin residence straight through to unloading and unpacking in destination residence—all on one bill of lading as though the shipment moved from Los Angeles to Houston.

The "door to door" mover's liability is limited as on a domestic move, and the shipper is afforded the opportunity of purchasing transit insurance above and beyond that provided by the bill of lading.

How to insure. It is best to insure for full value, since practically all marine policies contain a co-insurance clause.

Thus, if you insure a shipment for $10,000, and an insurance adjustment determines the goods moved were actually worth $15,000, the insurance company would pay any damages on the basis of 10/15ths, or two-thirds of any loss. The shipper thus becomes his own insurer for the uninsured portion, or the other one-third.

For example, if a shipment arrived in North Africa 60 percent water and fire damaged, the shipper would naturally file a claim for 60 percent of the total value of his goods ($15,000), or a claim for $9,000. He would normally feel well covered since he had purchased $10,000 worth of insurance—$1,000 less than his claim. Not so.

Settlement would be on the basis of two thirds of the insured value of $10,000, or $6,667. The difference between $9,000 and $6,667—about $2,333—would be the portion of the loss to be borne by the shipper.

An experienced overseas mover can prevent under-insuring by totaling the valuations taken from the contents-inventory, prepared at the time of loading in the residence, and insuring the shipment for this amount. When handled in this manner, it is virtually certain that no insurance adjuster would invoke the co-insurance clause

New door-to-door service for international moving

A smooth move, from Houston to the Middle East, starts with proper packing and detailed inventory (left). The cardboard box is celled and tiered by cardboard separators to receive glasses, dishes, etc. Spotless white paper is used to cushion the item within the cell. As each carton is filled, it is sealed shut and packed in a special export box (center). The carton now has a number, identifying contents. Carton number is written on outside of export box. When the export box is full, it is sealed shut and steel-strapped (insert). Note steel stiffeners in corners. Next stop: destination. Cargo is unloaded at right. International door-to-door moving services stress reduced handling, elimination of pilferage, simple inventory forms, and sharply reduced shipping weights.

of his policy since the declared value of the goods was taken directly from the shipper by a third party prior to movement of the goods.

For company representatives and others who arrange for overseas moving and insurance, this procedure is more satisfactory than having to explain to a fellow employe why the saving of a few insurance premium dollars had caused this employe to stand a loss that was not of his own making. And the employe's firm may wind up in the position of having to make up this loss.

New export packing method. Aside from the advantages of undivided responsibility, the international "door-to-door" service provides other worthwhile advantages, chief among which is the new export packing method.

Formerly, in an overseas move, a family's possessions were loaded into a van, from the van into a warehouse and then, after a period of time, into overseas boxes. Total handling? Three times. Three times that a stereo set, fragile china and dishes, furnishings, and so forth, could be dropped, scratched, chipped, broken or marred. Also, there was the possibility of pilferage of items while on the warehouse floor prior to being packed into export boxes.

Today's "door-to-door" mover may use a specially designed heavy-duty reinforced overseas box which is loaded at the residence under the watchful eye of the housewife. Every item is numbered and inventoried directly on a duplicating inventory form as it is placed in container, barrel or carton.

As each item or container is packed in the overseas box, this number is recorded on the duplicating master. When an overseas box has been packed full of barrels, cartons, etc., it is sealed shut and steel-strapped. Next stop: Destination.

Results? Reduced handling. Pilferage possibility practically eliminated. An inventory form acceptable to any customs bureau in the world. Complete accuracy in every detail. A real turnkey job.

At the same time, these advantages have been achieved with an actual reduction in weight and packing costs. Today's overseas boxes weigh considerably less than their old counterpart. The old overseas box provided 150 cubic feet of storage space with a weight of 600 pounds. Today's improved export boxes provide 192 cubic feet with a weight of 350 pounds.

Cellulose packing fillers. Remember the smeared, shredded paper and wood excelsior previously used in packing? These products have been discarded by some movers in favor of a new cellulose cushioning product, and a new type of security pad which consists of a layer of waffled felt paper sandwiched between two sheets of kraft paper. The number of layers of waffle paper can be varied to the packing needs.

These new materials and methods have streamlined even the old dish-packing operation. Glasses and dishes, cups and saucers are wrapped in pure white paper and then placed into specially corrugated containers which are celled and tiered with cardboard separators, greatly reducing damage hazards.

Select the right broker. Even with a host of new, time-saving methods and materials, an overseas moving job would be hopelessly complicated without the help of the freight forwarder or customs broker.

Some brokers appear to be more adept at handling shipments in certain areas of the world. One broker, for example, may be at home with shipments destined for the Far East; a second with North African shipments, and a third on shipments going to South America. It might be advantageous to select a broker on the basis of his majority experience.

With many international "door-to-door" movers, a family may select a broker with which it is most familiar and who, conversely, is most familiar with the family's over-all needs.

There are instances in which it may not be advantageous for an oil company to use the international "door-to-door" service, since the company may enjoy a favorable volume ocean freight rate from it's own steamship line, a rate which could not be offered by the "door-to-door" mover.

An optional "door-to-dock" service also is available. The customer receives identically the same methods and materials as in a "door-to-door" shipment except that the service and liability ceases when the shipment is delivered to the port of embarkation.

Spain plans special 1-year entry permits for Spanish Sahara workers

Officials of the Spanish Gulf Oil Company in Madrid say the Spanish government anticipates issuance soon of one-year permits for applicants who work in the Spanish Sahara, allowing an indefinite number of trips.

The new proposal is designed to supplant the present regulation which requires that an individual seeking to visit the Spanish Sahara first obtain a special permit and approval by the police. The special permit is issued by the office of Plazas y Provincias Africanas in the President's office.

About the Author

Bennett B. Watson, author of this article, is president of Watson Van and Storage Company, Houston and Corpus Christi. He has been in the moving business most of his life. He attended Rice University, then served as a flight instructor during World War II, following which he was employed as an engineer with a gas transmission company. He took over managership of Watson Van Lines in 1947. He was the first president of the Houston Movers Association and is a past member of the advisory board of Atlas Van Lines. His firm was the first in Houston to do export loading at the residence.

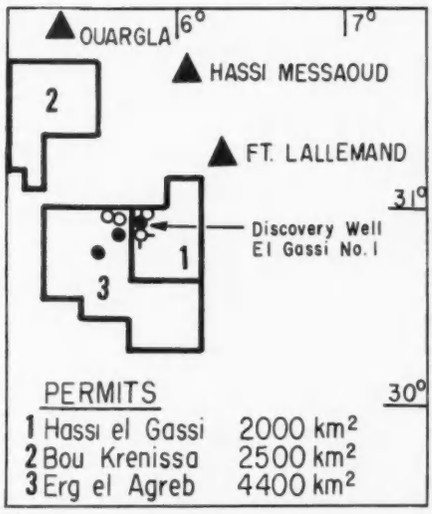
Lower Paleozoic prospects enhanced in Sahara area

New oil find at Hassi El Gassi is an important Cambrian sandstone field. Though smaller, it is similar in many ways to Hassi Messaoud:

- **Discovery well was drilled in a refraction seismograph prospect. Semi-detail refraction techniques have been developed in the Sahara.**
- **Production is from about 300 feet of Cambrian sandstone at about 10,500 feet, not far above basement.**
- **Despite tight nature of sandstone, wells have high flows—up to 2,000 bpd.**
- **But—permeability barriers and/or minor faulting cause irregular fluid contacts and impair water drive, if any.**
- **Summing up—Cambro-Ordovician sandstones cover much of Sahara in Libya and Algeria. Exploration for these prospects will continue for many years.**

A RECENT DEVELOPMENT in a series of important oil discoveries from Cambro-Ordovician sandstones in the Algerian Sahara is the new Hassi El Gassi—Erg El Agreb field, site of an active current drilling program.

A 10-inch crude oil pipe line extension is under construction from Hassi Messaoud. Oil from Hassi El Gassi will be pumped from there to the marine terminal at Bougie on the Mediterranean, starting on or about May 1, 1961. Upon completion, this new pipe line extension will move an initial 10,000 barrels daily of Hassi El Gassi crude.



* 1 Square Kilometer = 0.3861 Square Miles

FIGURE 1—Newest important oil reserve is shown at Hassi El Gassi—Erg El Agreb field, 75 miles southwest of Hassi Messaoud field. Existing pipe line facilities from Hassi Messaoud to the Mediterranean are being extended by a 10-inch spur line which will move 10,000 bpd of Hassi El Gassi crude by May 1961.

As of October 1960, there were five completed oil wells at Hassi El Gassi. The largest completion at that time was the discovery well, reported capable of producing 2,000 bpd.

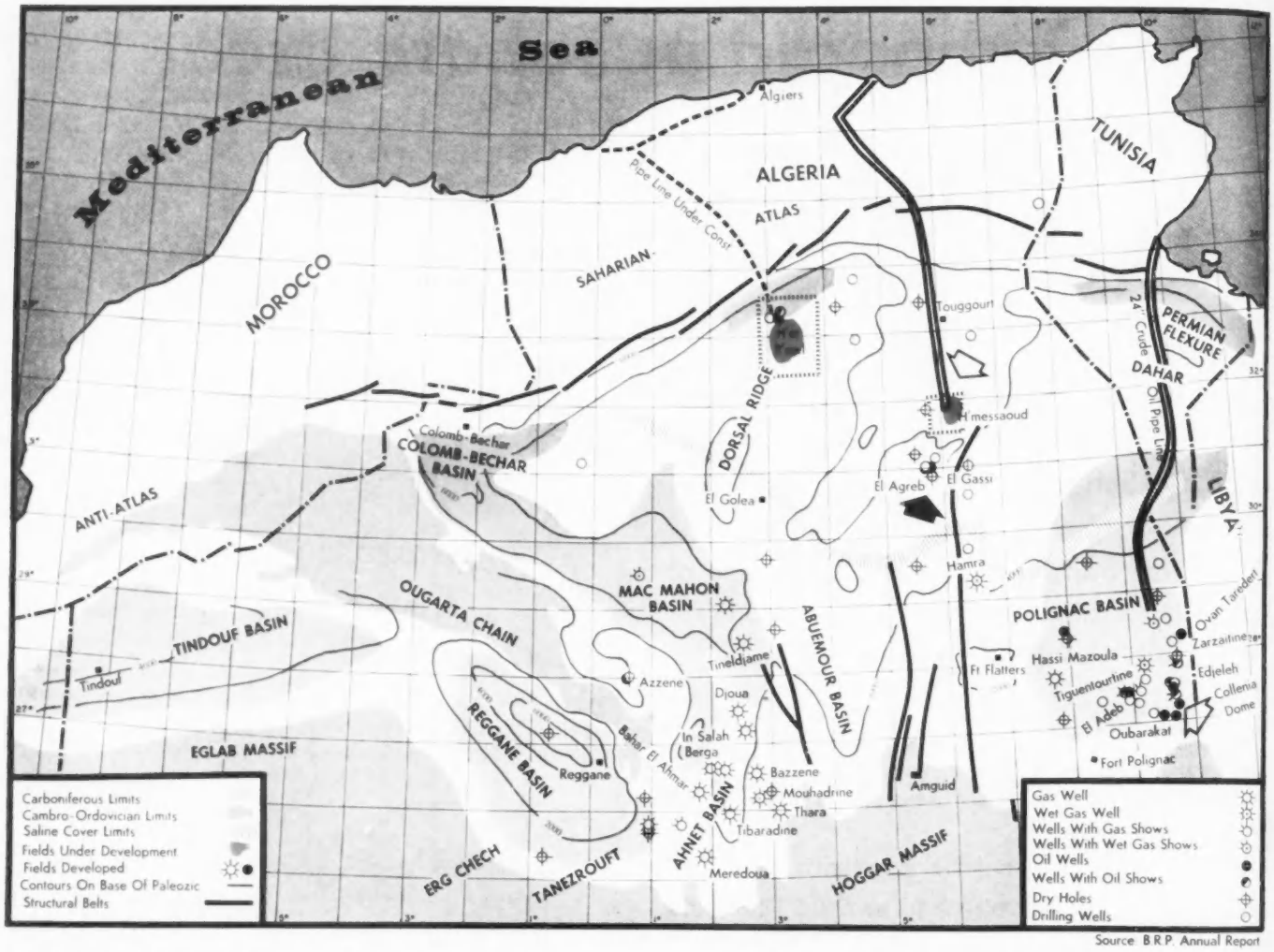
Cambro-Ordovician discoveries. The most spectacular event to date in Cambro-Ordivician exploration in Algeria occurred on June 13, 1956, when Societe Nationale de Recherche et d'Exploitation des Petroles en Algerie

TABLE 1—Correlation Table of Producing Formations by Fields, Lower Paleozoic Producing Reservoirs, French Sahara

Period	Epoch	Lithology	Hassi R'Mel	Hassi Messaoud	Hassi El Gassi-Erg El Agreb	Ahnet Tademait	Edjeleh	Tiguentourine	Zarzaitine	El Adeb Larache	Other Fields of the Polignac Bassin
Permian: Carboniferous	Lower Upper	Sandstone Sandstone				G	O O	O O	O O		
Devonian	Lower	Sandstone				G	O	O	O	O	O
Ordovician		Sandstone				G		G			O
Cambrian		Sandstone		O	O						

Legend: O—Oil. G—Gas.

Data Source: Bureau de Recherches de Petrole, Paris, France



Source: B.R.P. Annual Report

FIGURE 2—Cambro-Ordovician objectives are being sought in a major exploration effort throughout the French Sahara. Lower Paleozoic sediments underlie much of Libya also. This tectonic map of the Algerian Sahara is contoured on the base of Paleozoic rocks where they are present, and it also shows pre-Cambrian massifs and mobile belts. Solid arrow locates new Hassi El Gassi field, productive in Cambrian sandstones, and hollow arrows show Hassi Messaoud, largest Cambro-Ordovician oil field yet found, and two 1958 Cambro-Ordovician discoveries, Collenia dome and Ouan Taredert near the Libyan border.

found 43° gravity, sulfur-free crude oil at a depth of 10,830 feet on its eighth Sahara wildcat drilled on its Oued Mya concession. This is the now-famous Md 1, discovery well of the Hassi Messaoud field. The productive area now exceeds 500 square miles.[1]

There is considerable controversy as to the recoverable reserves figure to be assigned to Hassi Messaoud field. Crude oil in place is estimated as high as 20 billion barrels, but owing to poor reservoir characteristics of the pay sand,[1] crude oil recoverable by primary means has been more conservatively estimated by WORLD OIL at about 1¼ billion barrels.

The first Ordovician oil found in the Fort Polignac Basin in extreme eastern Algeria on the Libyan border was discovered on the Collenia dome in 1958. Compagnie de Recherches et d'Exploitation de Petrole au Sahara DC 1, drilled on the basis of subsurface geology, was completed from 60 feet of Cambro-Ordovician pay at a depth of 3,170 feet.[2]

Another Cambro-Ordovician discovery was made in 1958 about 19 miles northwest of the Collenia dome at Ouan Taredert, also on a subsurface geology prospect. There is 76 feet of pay in the discovery well at about 4,900 feet.[2]

The fourth Cambro-Ordovician discovery in Algeria was made early in 1959 on a refraction seismograph prospect 75 miles southwest of Hassi Messaoud. This new field, Hassi El Gassi—Erg El Agreb, falls on two contiguous concessions.

Discovery well. Societe Nationale des Petroles d'Aquitaine, operator of the Hassi El Gassi concession, drilling for itself and its partners COPAREX, FRANCAREP and EURAFREP completed its GS 1 as the discovery well on April 8, 1959. Total depth was 12,014 feet. More than 300 feet of oil pay was encountered in Cambrian sandstones with an initial flow rate of 75 barrels of oil per hour under 1,000 psi pressure. Refraction seismograph

had indicated a large anticline with major axis striking northeast to southwest.

Southern limits of the new field were determined by SNPA GS-2, six miles south of the discovery well. Cambrian objectives were encountered about 900 feet lower structurally then in the discovery well, and below the oil-water contact.

SNPA moved to its Erg El Agreb concession and drilled an extension oil well in Cambrian reservoirs at AR 1, located nine miles southwest of the discovery well. AR 1 encountered Cambrian sandstones about 40 feet structurally lower than GS 1 in a new oil reservoir. It appears that the two accumulations of oil are separated either by a fault or by a permeability barrier.

As of October 1960, there were five completed oil wells: GS 1, and AR 2, 6, 7, and 8. Of the 10,000 bpd initial flow schedule slated to begin next May, about 8,000 bpd will be taken from the latter concession and the rest from the discovery well.

Late in 1960 there were three active drilling rigs in this field, two of them contract rigs. Cambrian sandstone pays were being developed at depths between 10,000 and 11,000 feet.

Vast Sahara area enhanced. Cambro-Ordovician prospects are beginning to be evaluated over a 2,000-mile east-west area from the Gulf of Sirte Basin in Libya to the Tindouf Basin in extreme western Algeria. Mobil Oil of Canada Ltd. Amal 1, discovery in Block 12 in eastern Libya was completed for 990 bpd of 34° gravity crude from Paleozoic sandstone at 9,835-10,406 feet.[3] Cambro-Ordovician sandstones and quartzites cover much of Libya.

The Tindouf Basin is believed to have lower Paleozoic possibilities, below known Carboniferous sediments which underlie Cretaceous beds. Geological and geophysical reconnaissance was conducted in 1954-1956 by Bureau de Recherches de Petrole. Favorable results led to requests for permits covering very large areas.

Societe Anonyme Francaise de Recherches et d'Exploitation de Petrole commenced a series of long transverse seismic profiles in the fall of 1959. Gravity leads were checked in some areas.

Like the Reggane Basin, the Tindouf Basin is a vast assymetrical synclinorium with its major axis trending essentially west-east. Tectonics bordering the Anti-Atlas Mountains are complex. The south flank of the basin rises gradually against the Eglabs Monocline, and the Paleozoic series thins southward.

LITERATURE CITED

[1] "Algeria . . . New pipe lines allow production spurt," WORLD OIL 151, No. 3 153-160 (1960).
[2] "Algeria . . . New petroleum code and booming concession activity highlight development," WORLD OIL 149, No. 3, 163-165 (1959).
[3] "Libya . . . big oil fields found in both eastern and western regions; drilling booms," WORLD OIL 151, No. 3, 151-152 (1960).

Know your basement in North Africa

Post-Cambrian orogenies renewed older, discordant structural trends, complicating overlying strata

KNOWLEDGE OF THE CHARACTERISTICS of basement rocks is essential to successful exploration in North Africa.

Depending on the area, basement may consist of granite or gneiss, totally unmetamorphosed sediments, quartzite, or of combinations of different igneous, sedimentary, and metamorphic rocks. The basement has a strong influence on geophysical information, particularly on magnetic and refraction seismic data. Proper interpretation may result in very accurate geophysical exploration. Erroneous findings may prove costly.

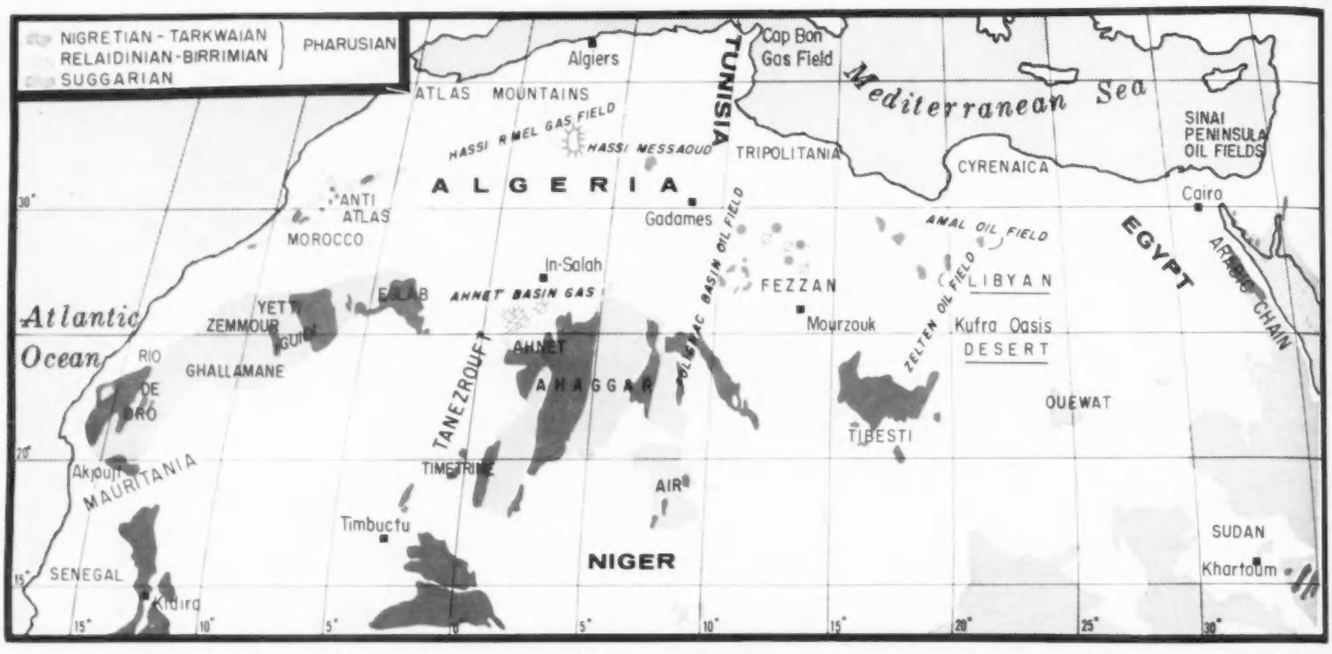
Since most of the best prospects in North Africa outside of the Sirte Basin of Libya lie in Paleozoic beds, the basement is especially important since it is not far below prospective pay horizons, particularly Cambro-Ordovician sandstones productive at Hassi Messaoud and elsewhere in the Sahara. The basement is of extreme importance in the vast gas accumulation of Hassi R'Mel, located along the Algerian Sahara dorsal ridge. Basement structure was probably important also in the development of the Hassi Messaoud closure.

Anomalies showing on gravity and magnetic data may be either strictly intrabasement ones or may be due to events in the sedimentary section above.[1] However, since geophysical problems relative to the basement are becoming better understood, the existence of intrabasement anomalies permits more accurate interpretation of magnetic data for purposes of estimating depths to basement in the Sahara.[2]

In some parts of Africa the surface geology is imperfectly known and much work remains to be done on basement rocks. A pre-Cambrian inlier located west of the limit of crystalline outcrops was only recently found in the Spanish Sahara.[3] Basement was recently found at about 1,850 feet in the first test drilled in the Spanish Sahara.

Geologic outline of Libya. Cambrian and Ordovician sandstones and quartzites cover most of Libya. Western Libya is divided into two distinct basins, the Gadames (on the northwest) and Mourzouk (southwest), both containing Paleozoic sediments primarily.

Libya is geologically divided by a north-south Silurian trend from Tibesti through Gargaf to Garian. East of this trend some early Paleozoic sediments are present, particularly in the Kufra Basin. Eastern Libya's main area of interest is the Cretaceous-Paleocene Sirte Basin. Mobil Oil of Canada hit basement at 6,170 feet in well A1-57, but actual basement rocks had not been drilled in other tests in the Sirte Basin as of late 1960. Several wells elsewhere in Libya have reached basement.[4,5]



General distribution of pre-Cambrian outcrops in the Sahara. The classification shown is that of M. Lelubre (1953).[18] Suggarian, Relaidinian—Birrimian and Nigretian-Tarkwaian type series may be related to Table 1 and to the text.

TABLE 1—Tentative Correlation Chart of the Pre-Cambrian of West and Northwest Africa*

Morocco	Mauritania and Senegal	Guinea and Sierra Leone	Gold Coast and Ivory Coast	Togo and Dahomey	Nigeria and Sudan-Niger
Eo-Cambrian?		Kambia and Forecariah Beds.			Tondigaria Beds.
Granite	Basic Intrusives.	Granite porphyry, quartz-porphyry, and basic intrusions.	Pyroxenite, gabbro, serpentine.	Pyroxenite, gabbro, serpentine.	Basic intrusions.
Pre-Cambrian III	Falemian.	Youkounkoun Beds?	Buem.	Buem.	Douentza.
		Falemian and Rokell series.			Labbezenga?
G 2 granites	Alkaline and granite and syenite.	Alkaline syenite.	Alkaline syenite.	Granite and basic intrusions.	Younger Granite.
Gabbro, pyroxenite, peridotite	Granites.		Granite, porphyry and basic intrusions.		Porphyries.
					Rhyolites.
Pre-Cambrian II	Sangola. Akjoujt?		Alkwapimian and Tarkwaian.	Togo and Atacora.	Labbezenga? and Ansongo.
G 1 granites	Granites.	Granites.	Granites. Ultrabasic and basic intrusions and diorite.	Granites.	Granites.
Pre-Cambrian I	Bakel?	Upper Birrimian? Marampa.	Upper Birrimian.	Gneisses and schists (Dahomeyan)	Yatakala?
	Thiagnaf.	Kambui.	Porphyries and granite?		Gneisses and schists (in part Dahomeyan).
	Amsaga.	Simandou. Kasila and Dahomeyan.	Lower Birrimian and Archaean.		

* After N. R. Junner.

Major North African massifs. North Africa has a number of pre-Cambrian massifs, as follows:

- Algeria: Ahaggar and Air
- Libya: Tibesti and Ouewat
- Morocco: Central Moroccan Chain; Principal Chain
- Spanish Sahara: Rio de Oro massif
- Egypt: Arabic Chain.

Upper pre-Cambrian distribution. In Morocco, the upper limit of pre-Cambrian has been closely determined. Fossiliferous Georgian Cambrian limestones overlie continental deposits (coarse conglomerates, lavas, tuffs, and breccias) described by Choubert.[6]

Algal remains (*Conophyton* and *Collenia*) occur in the Cambrian of the western Sahara and of Morocco. They are also found in pre-Cambrian of Central and South Africa where their age has been determined in connection with the age of pitchblende in Katanga. Systematic age determinations are urgently required in North Africa, particularly by radioactive dating methods, to develop a more satisfactory classification of principal pre-Cambrian formations.

Cambrian transgression probably extended all over West Africa.[7] Flat-bedded Cambrian sediments often un-

conformably overlie either gently-folded continental deposits (feldspathic sandstones and conglomerates) or more highly folded calcareous and arenaceous sediments known as Falemian (Table 1). Red beds occur in both types of formations, particularly in the upper series where red arkoses and conglomerates of the Kambia[8] and Forecariah[9] series, and possibly also the Tondigaria sandstones of Niger[10] may be included in this connection. Red beds are also found in the younger lower Paleozoic.

Volcanics occur in the Buem, Rokell, Nigretian and pre-Cambrian III beds (Table 1 and map, Page 74). The latter two series are principally rhyolites and andesites; those in the Buem are sodic types ranging from rhyolites thru trachyandesites to basalts.

Late pre-Cambrian granites and alkaline syenites corresponding to those of southern Africa and Morocco have not been recognized definitely in West Africa, apart from the granite porphyry in Youkonkoun beds. The Afted granite of the Eglab region of Algeria,[11] which includes the Guelb el Habid series (middle or late pre-Cambrian) may possibly belong to this period. The younger pre-Cambrian granite of Nigeria seems to predate pre-Cambrian III rocks since pebbles of it are reported in the Nigretian.[12]

The western Mauritania pre-Cambrian as previously described[13] consists of two series of crystalline schists, granites, and younger basic rocks.

The oldest pre-Cambrian described (the Amsage series) consists of feldspathic gneiss, ferruginous quartzites, and earlier biotite or hypersthene orthogneisses. The Amsage series experienced strong folding and intense metamorphism, and was covered by what is now the Akjoujt complex of quartzites and chlorite schists. The Akjoujt series is described as consisting of two separate contact metamorphic ensembles. Some later basic intrusives are believed to be late pre-Cambrian in age; still later basics are thought to be of Paleozoic age.

Morocco. The older pre-Cambrian chain of the Anti-Atlas (Huronian?) is covered by a Pre-Cambrian III series, composed of a succession of discordant complexes of detrital and volcanic formations.[6] This continental assemblage is in turn discordantly covered by beds from the Georgian transgression.

TABLE 2—Probable Sequence of Tectonic Events, Algerian Sahara*

Age	Comments
1. Pre-Cambrian	Very strong folding, faulting.
2. Paleozoic a. Caledonian	Broad movements along east-west axis.
b. Hercynian	Intensive orogeny, particularly in final stages. Formation of chains oriented generally north-south.
3. Post-Eocene, pre-Miocene	Rejuvenation of Hercynian structure.
4. Post-Miocene (?)	Principal folding along northwest-southeast axis.
5. Post-Pliocene (?)	Possible movement throughout northern region. Aures folding along east-west major axis.
6. End of early Quaternary (Risswurm interglacial period)	Folding affected middle Pliocene and accompanied early Quaternary; principal structural axis is northwest-southeast.
7. Neolithic	Some gentle folding.

* Sources; R. Karpoff[19], and Chadenson (data on early Quaternary).

In the Georgian are two recognizable sedimentary cycles separated by a very general transgression. *Olenellidae* and *Archaeocyathidae* characterize the first cycle, but are absent from the second. The first cycle consists essentially of carbonates, attaining a 10,000-foot thickness in the subsidence zone to the south. Such pre-Cambrian deposition is obviously of the same order of magnitude as the Beltian or Keweenawan zones of North America.

Spanish Sahara. Medina's study[15] of the Spanish Sahara pre-Cambrian notes two fundamental series. The older one is intensely regionally metamorphosed ("magmatised and granitized?"); it corresponds with the Suggarian of Kilian.[16] The later series is still more intensely metamorphosed, and corresponds to Kilian's Farusian group. Both series contain magmatic cycles with intensity decreasing with time, and both series have been further affected by subsequent tectonic movements.

Libya. The Tibesti and Ouewat massifs of southern Libya are highly complex bodies of Archaeozoic crystalline schist intruded by igneous rocks. They have been partially mapped and their mineralogy and petrology have been thoroughly described in Italian literature.[17]

The schistose core of the Tibesti massif in Libya is associated with granitic bodies and is also partially covered by extrusive Tertiary basalt. The Ouewat massif is similarly complex. It is mapped as a mass of Archaeozoic crystalline schist intruded by igneous rocks.

Large exposures of extrusive Tertiary basalt are scattered over many parts of the surface in Libya, overlying not only the pre-Cambrian at Tibesti but also Siluro-Devonian beds on the north flank of the Tibesti massif, Cretaceous strata in southern Tripolitania, and middle Eocene in the Mourzuc region of the southeastern Fezzan, among other areas. These highly weathered ultrabasic surface rocks are bound to affect geophysical exploration in Libya.

LITERATURE CITED

[1] Brundage, H. T., "Where is Basement?", World Oil 151, No. 5, 170-188 (1960).
[2] Steenland, N. C., Geological Society of America Memoir 47 (1951).
[3] "Spanish Sahara . . . evaluation studies proceeding rapidly," World Oil 151, No. 2, p. 160 (1960).
[4] "Libya . . . big oil fields found in both eastern, western regions," World Oil 151, No. 3, 151-153 (1960).
[5] World Oil 147, No. 3, 200-201 (195..).
[6] Choubert, G., Note on the Geology of the Anti-Atlas (1951).
[7] Furon, R., Geology of Africa, Paris (1950).
[8] Junner, N., Annual Report, Gold Coast Geological Survey, p. 19, 1938-39; and Annual Report, Sierra Leone Geological Survey, p. 9, 1927-28.
[9] Arnaud, G., "On the new attainments of the geology of French West Africa after 1940," Report, Eighteenth Session, International Geological Congress, 14, 56-60 (1951).
[10] Serpokrylow, S., Geologic map of the plateau of Bandiagara, Serv. Geol. A. O. F., Dakar (1934).
[11] Gevin, P., "On the structure of the crystalline massif; Eglab-Yetti" C. R. Ac. Sc., t. 233 (1951).
[12] Karpoff, R., "The granites of the Sahara," C. R. Ac. Sc., t. 228 (1949).
[13] Blanchot, A. J., "The Pre-Cambrian of western Mauritania," Report, Nineteenth Session, International Geological Congress, Pre-Cambrian and ancient primaries, 95 (1952).
[14] Delany, F. M., "Recent contributions to the geology of the Anglo-Egyptian Sudan," Report, Nineteenth Session, International Geological Congress, General, 11 (1952).
[15] Medina, M. A., "The Pre-Cambrian of the middle Spanish Sahara," Report, Nineteenth Session International Geological Congress, Pre-Cambrian and Ancient Primaries, 73, (1952).
[16] Kilian, C., "General survey of the structure of Tassilis of Ajjers," C. R. Ac. Sc., t. 175, 825-827 (1922).
———"On the conglomerates of the central Sahara, the Pharusian and the Suggarian" C. R. somm. S. G. F. 87 (1932).
———"The African Pre-Cambrian", C. R. Ac. Sc. t. 224, 350-352 (1947).
[17] Desio, A., Chiesa, C., Lipparini, T., and Marchetti, M., Missione Scientifica della Reale Academia D'Italia a Cufra, Viaggi di Studio ed Esplorazione, Vols. 1 and 3, Rome (1934).
[18] Le Lubre, Maurice, "Stratigraphy of the Pre-Cambrian of the Sahara," Bull. Soc. Geol. Fr. t. 3, fasc. 7-8, 547-577 (1953).
[19] Karpoff, R., "Les Subdivisions et les correlations de l'antecambrien," Fasciscule I, p. 224, Algiers (1953). International Geological Congress, Algiers, 1952.

BIBLIOGRAPHY

Joulia, Fracois, "On the existence of an important system of interesting fractures of intercalated continental rocks to the west of Air, Niger," Bull. Soc. Geol. Fr. Ser. 6, t. 9, fasc. 1-3, 137-143 (1957).

How the Sahara's geophysical problems are being resolved

Refraction seismic work yields improved regional and semi-detail data; telluric, gravity work help

GEOPHYSICAL OPERATIONS IN THE SAHARA have been hampered by the extreme remoteness of most areas; by difficult surface and weathered-zone conditions in many localities such as sand dune (erg) regions and by highly variable characteristics of the basement. A unique hazard to geophysical and surface geological work alike is that of World War II land mines[1] which were sown virtually throughout the entire Mediterranean coast of western Egypt and Libya. The Libyan government publishes a map showing all *known* land mine areas.

The need for geophysical exploration in the Sahara is particularly great in the Triassic Basin of Algeria. Prospective Mesozoic formations outcrop far to the south and Paleozoic beds are exposed even farther southward.[2]

WHY INTERPRETATION IS COMPLICATED

The pre-Cambrian surface is not featureless. A basement uplift under the Sahara dorsal ridge near Berriane had been defined by geophysical works as early as 1954. The closed structure in lower Triassic sandstones above this basement feature has since been proved by development of the huge Hassi R'Mel gas field, with gas reserves estimated at between 35 and 70 trillion cubic feet.

In addition, the basement in the Sahara is not entirely crystalline but includes some ancient sediments, some of which are relatively unaltered. In the Sirte Basin in Libya, a quartzite formation which is so difficult to penetrate that it acts as basement for drilling purposes, lies above the ultimate crystalline basement.

Strong attention is being paid to the nature of the basement in the Sahara. In the Spanish Sahara, some flight lines in a recent airborne magnetometer survey were extended over crystalline areas to help determine the basement's magnetic nature and to enhance the accuracy of estimates of depths to basement in sedimentary areas.[3]

Paleozoic-Mesozoic stratigraphic complexities. Development of the Hassi-Messaoud field, among other drilling events in the Sahara, has shown that part of the difficulty in geophysical interpretation is due to complex pre-Tertiary stratigraphy. Hassi-Messaoud is now known to be a huge, flat, "bald-headed" structure with Cambro-Ordovician being truncated by Triassic. Truncated Paleozoic sandstones covered by unconformable Triassic sandstones caused difficulties in early stratigraphic determinations and no doubt complicated seismic interpretation also. Since the pay sandstone lacks fossils and lies below evaporites known to be of Triassic age, the Hassi-Messaoud reservoir was believed originally to be of Triassic age also. Its dating was later changed to Cambro-Ordovician after basement was found below the base of the oil-bearing sandstone formation.[4]

Younger beds not conformable. A mantle of Miocene, Pliocene and Quaternary beds lies above the Mesozoic in the Triassic Basin of Algeria, masking older sediments which aggregate a possible maximum of 30,000 feet of thickness. Hence geophysical methods have been essential to augment surface geology in the search for Sahara oil in the deeper portions of the Triassic Basin and they have been very useful for detailed surveys of outcrop areas as well. Special techniques designed to overcome the more difficult surface and weathered zone conditions in addition to the subsurface problems have enjoyed varying degrees of success.

GRAVITY COVERAGE

The first widespread geophysical coverage of the Sahara started in the early post-World War II years. Since at the time the gravity meter was the conventional reconnaissance exploration tool, it was widely used. The aerial magnetometer has more recently become prominent for reconnaissance survey work.

By the end of 1956, pursuant to gravity work done mainly by Compagnie Generale de Geophysique (GGG) (one of the pioneer geophysical contractors in Algeria), a general reconnaissance gravity map of the entire central Sahara between the Atlas Mountains, the Saoura, the Paleozoic of the northern Hoggar and the Grand Erg

Oriental had been developed. Some gravity anomalies were evident in the CREPS concession in eastern Algeria.[5] These anomalies helped locate structures which were later proven at Tiguentourine and Zarzaitine.

Farther north in the CFP (A) and SN REPAL[6] permit areas, now famous as the Hassi-Messaoud field area, results from reconnaissance gravity surveys were somewhat negative at first, although detailed gravity work has more recently indicated sedimentary structure. First results obtained in this area from detailed gravity surveys with stations regularly spaced from two to three per square mile, are encouraging.

ELECTRICAL SURVEYS

In the CREPS permits in South Algeria, good results were reported[5] in detailed Palezoic structures via telluric methods, without interference owning to the nature of the basement. Farther north, results from telluric surveys have been less favorable. However, a map of the Lagouhat-Ghardaia-Ouargla-Biskra quadrangle was developed from telluric work which proved to be similar to a later one obtained from refraction seismic data.

SEISMOGRAPH WORK

Reflection. Early attempts at reflection work in the northern Algerian Sahara showed the signal-to-noise level was excessive. In later work, many geophones were used instead of a single detector and multiple charges were used also. Thus pattern detectors were combined with pattern shooting.[7] In some regions, a spread of 80 jugs per trace was used, covering about one hectare (2.471 acres) and 80 shot holes were spread over one hectare, to obtain a multiplication coefficient of 6,400. One of the few advantages of operating seismograph crews in the remote Sahara is that large-scale pattern shooting can be conducted without causing any property damage.

Reflection seismic functions more readily in the southern Sahara. The now-productive Tiguentourine and Zarzaitine structures were outlined by reflection seismic work.

Refraction seismic work has enjoyed a comeback in the Algerian Sahara. This method had been kept essentially dormant since the search for very large structures in the United States gave way years ago to the more detailed reflection approach in search of smaller ones. Recently modern improvements in field operations technology[8] have been more specifically applied to refraction crews. Magnetic tape and variable density and variable area techniques to improve instrumentation and interpretation, originally developed mainly for reflection work, have also been applied to refraction seismic.

Early refraction shots in the Algerian Sahara in 1952 indicated a high-velocity datum (almost 20,000 feet per second) which was assumed to represent basement. An early continuous refraction profile from Ghardaia to Berriane showed that this datum could be followed in certain areas. The first northern Algerian Sahara deep test, at Berriane, Hassi R'Mel 1, was located on the highest point of this profile.

Further work developed new refraction datum points which complicated interpretation. To identify these markers, several recordings were obtained from different shooting distances. Two recording trucks were used simultaneously.

Photo courtesy Compagnie Generale de Geophysique

Refraction crew detonates weathering shot in Algerian Sahara to determine thickness of low-velocity zone.

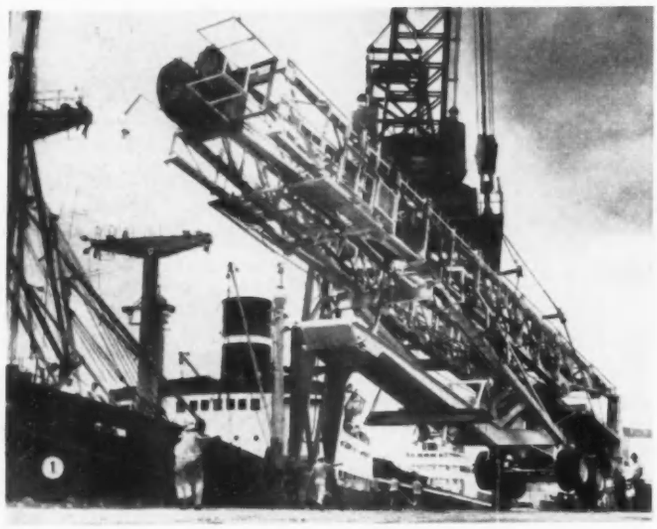
Refraction work thus provided basic coverage to the Triassic Basin of the northern Algerian Sahara. The configuration of the basement was indicated and leads were developed to guide follow-up detail geophysical surveys. The Hassi-Messaoud structure, in a relatively deep portion of the Triassic Basin, was indicated and was drilled on the basis of refraction work. The pay sandstone at Hassi Messaoud lies below 10,400 feet; the basement is found at about 13,000 feet.

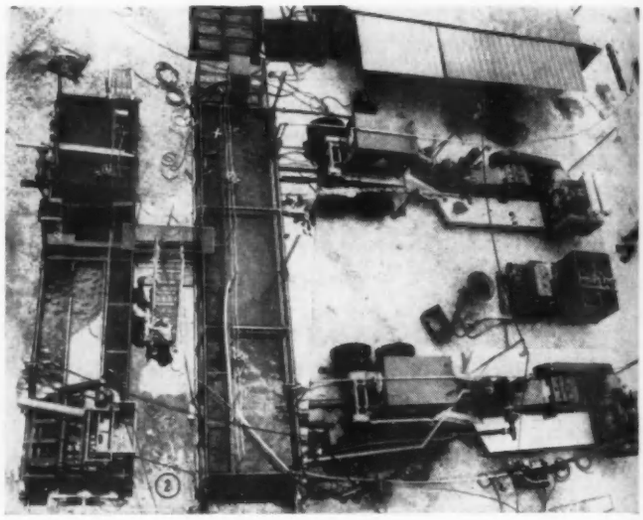
Weight-dropping has been used successfully in Algeria. Similar to developments in seismograph techniques, a large number of successive weight drops have been used to develop sufficient energy to provide satisfactory results. In some areas weight-dropping may provide equal or better results as compared to seismograph work.

The weight-dropping method is also being used in Libya.

LITERATURE CITED

[1] "Wartime Mines a Costly and Dangerous Problem in Egypt," World Oil 141, No. 6, 240-246 (1955).
[2] "Prospecting in Southern Algeria," World Oil 150, No. 2 p. 76 (1960).
[3] "Spanish Sahara . . . Evaluation studies proceedings rapidly," World Oil 151, No. 3, p. 160 (1960).
[4] "Brundage, Harrison T., "Where is the Basement?," World Oil 151, No. 5, 170-188 (1960).
[5] "The Role of Geophysics in the Discovery of Oil in the Sahara," Compagne Generale de Geophysique brochure, Paris (1959).
[6] "Algeria—New pipe lines allow production spurt," World Oil 151, No. 3, 153-159 (1960).
[7] Waldie, A. D., 'Algeria's Sahara: booming seismic frontier," World Oil 146, No. 5, 126-134 (1958).
[8] Vetterlein, Pascal, "How to do refraction work by remote control," World Oil 150, No. 5, 114-116 (1960).





The truck-mounted drilling mast (Figure 1) mounted on dual trailers is shown in horizontal position while being lifted aboard ship in Houston for shipment to the Spanish Sahara. In this position, it is easily transported by truck over rough topography in West African desert. Figure 2 shows the integrated mud system. Each pump is mounted on an individual sinkable trailer which forms the base skid during drilling operations. Complete camp facilities (Figure 3) for the Spanish Sahara operation are

How the contractor drilled first Spanish Sahara well

Lack of water, rugged terrain and unusual living conditions were among many problems encountered

THE FIRST DRILLING PROGRAM for the Spanish Sahara on the arid and remote coast of West Africa was assigned early in 1960 to Falcon Seaboard Drilling Company of Tulsa by the Spanish Gulf Oil Company, CEPSA, Spanish independent and associates.

New Subsidiary. Because of the scope of the new operation, Falcon Seaboard of Panama, S. A., was formed on May 31, 1960, as a wholly-owned subsidiary. The new corporation was established for the purpose of contract oil well drilling in concessions in the Spanish Sahara with operations commencing in July 1960.

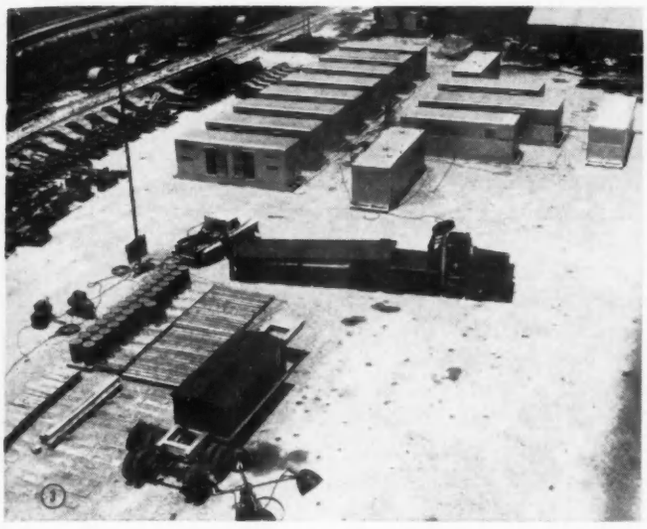
Headquarter offices were set up in Las Palmas, capital of the Canary Islands 120 miles off the coast of West Africa by E. L. Walton, general manager of foreign operations and vice president of the subsidiary company with the assistance of Fred Fisher, resident manager. Management at Las Palmas are under the direct supervision of Fisher and William D. Cady, his office manager.

Other key employes sent from the United States included a drilling foreman, four drillers, mechanic and a transportation manager. Spanish personnel employed on the project totaled about 36 men.

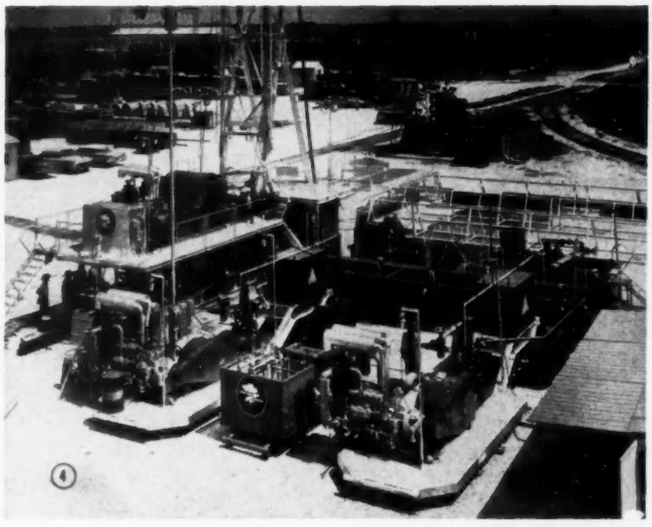
Rig design. The drilling rig employed in the Spanish Sahara was designed for maximum portability in rough terrain. Several new unique design features were made in the mast, slush pumps and the compressor assembly.

From its horizontal position while telescoped and mounted on dual trailers, the drilling mast is easily transported over rough topography. (See Figure 1) The height of the mast is 97 feet. Normal gross capacity is 352,000 pounds with a hook-load rating of 250,000 pounds using eight lines.

Drawworks components. The drawworks is rated at 300 HP and equipped with a torque converter and hydromatic brake. It is powered by a twin diesel engine which delivers 278 continuous horsepower. Other rig components include a 17½-inch rotary table, a hydrahook traveling block and a 200-ton swivel. The rig has



provided for a 48-man crew. The seven air-conditioned units are shown at left with an office unit in the back. In the center (Figure 3), two bath-laundry combination units flank the dining-recreational-kitchen facilities. At extreme right is a gen-



erator and water-purification unit. Pre-assembly and power testing of the complete 7,000-foot drilling rig of Falcon Seaboard of Panama, S.A., was conducted at Houston ship channel yard (Figure 4) of the rig manufacturer.

a factory-rated depth capacity of 7,000 feet, using 3½-inch drill pipe.

Mud system. Each pump is mounted on a sinkable trailer with the trailer forming the base skid during drilling operations. (See Figure 2) This minimizes loading and unloading for maximum efficiency in moving operations. Each pump is driven by a twin 300 HP diesel engine. Equipment includes two 150-barrel mud tanks, a shale shaker, a desander and a chemical mixer.

There are two skid-mounted water-storage tanks and one dry-mud storage bin. Fuel is carried in two 2,000-gallon skid-mounted fuel tanks.

Air drilling operations in the water-scarce Sahara is being utilized with the aid of four portable compressor units plus one booster. Each unit is driven by a twin 300 HP diesel engine.

Camp facilities. Complete living quarters are provided for a 48-man crew. Housing includes 15 trailers, (See Figure 3) 14 of them skid-mounted units to provide: 1 unit for offices, 7 air-conditioned sleeping units (two 4-man and five 8-man units), two air-conditioned dining and recreation units, a kitchen unit, a food-storage unit, and two bath-laundry combination units. Two 100-kw. generators power the water purification apparatus.

Transportation fleet. A complete transportation fleet was selected and designed for maximum efficiency under the most severe weather conditions encountered in the Spanish Sahara.

Trucks include four diesel tandems with two trailer floats and a bulldozer mounted with a 12-foot wide blade for earth moving operations. Two of the trucks have a 20-ton load capacity with 294-inch wheelbase with tandem rear axle and power steering. Each truck is driven by a single 300-HP diesel engine.

The two remaining trucks have 10-ton load capacity, 190-inch wheelbase with tandem rear axle and power steering.

Two trailer floats have a 25,000-pound capacity, and are mounted on a single axle.

Pre-assembly. The equipment was completely assembled and power-tested at an assembly plant in Houston (See Figure 4). During the week of June 1960, all equipment was loaded aboard ship (see Figure 1) for transportation to the port of Las Palmas in the Canary Islands, 120 miles off of the African coast.

The shipment arrived on July 18, 1960, without difficulty although the last three days of the Atlantic crossing encountered rough seas. A record time for unloading the equipment at Las Palmas was made during the period from July 18 to 21.

Sub-contracting difficulties with trans-shipment for the mainland trip required two weeks. However, the first truck picked up its first drill-site load on the beach and arrived at the first drill site in the desert on Aug. 15, 1960.

Water supplies. The desert haul from the beach to the first drill-site is a distance of about 175 miles. With four trucks working around the clock, the rig and camp were moved in about two weeks. The first well, SPANGOC 10-1 in block 3 was spudded on September 3.

Temporarily, fresh water is loaded at Las Palmas in wine barrels, trucked abroad in small vessels to the beach and then trans-loaded to supply trucks for hauling to the campsite.

Work cycle. The work schedule calls for a 3-week work period at the rig with one week off at Las Palmas. Personnel are transported between the drill-site and Las Palmas by air in 1½ hours.

Falcon Seaboard of Panama, S. A., maintains an office and a 3-bedroom apartment in Las Palmas for its employes.

Lofty sand dunes. Coastal sand dunes, rising to heights up to 150 feet are found in the region of El Aaiun, an

army outpost. The distance between the beach and the outpost is 18 miles. Driving time, using a 4-wheel drive vehicle requires 45 minutes with an average speed of 24 miles per hour. Prevailing coastal winds are from the north.

The army keeps the roads open between the two points. At times as many as 50 soldiers will remove a dune 100 feet in height over an acre of ground, using shovels. The sand is thrown into the air and is carried away by the wind, cutting a road.

Crews report considerable axle and tire damage between the beaches and drill-sites. Drivers report an average of three flat tires for each round trip at speeds averaging only 15 miles per hour due to excessive tire wear from sharp rocks emerging from the hard desert floor.

Strikes basement rocks. The first exploratory drilling operation in the Spanish Sahara encountered pre-Cambrian granite basement rock on Sept. 29, 1960, at a depth of 1,804 feet. No water was encountered during drilling operations. Fresh water supplies are at a premium in the interior.

Second exploratory test. The rig was skidded on October 3, to the next location 18 miles to the northwest on the same concession tract.

After setting 105 feet of 10¾-inch surface pipe, excellent penetration progress was reported using conventional rotary mud to the protective casing point of 3,822 feet, where 7⅝-inch casing was set. The average penetration rate was 191 feet per day over a period of 20 days.

After cementing the protection casing at 3,822 feet, drilling was resumed using air as the circulating medium. The average penetration rate from 3,822 to 4,637 feet was 68 feet per day during a 12-day period.

Drilling in the Libyan desert

In an exclusive interview, Loffland Brothers explains procedures in the world's largest and most arid desert

Editor's note: Following is an exclusive interview arranged by the editors of World Oil with Ken Davis, Jr., president of Loffland Brothers Company, Tulsa, Oklahoma, one of the leading drilling contractors operating in Libya.

Loffland Brothers has been operating in Libya since 1957, and is now using six rotary drilling rigs rated from 1,600 to 1,800 horsepower. Their current drilling contracts include 4 rigs for Esso Standard (Libya), 1 for Mobil Oil of Canada Ltd. and 1 for Oasis Oil Company. Depth ranges are from 6,000 to 13,000 feet:

Q *Mr. Davis, where are your rigs shipped from?*

A Houston, Texas, and Maracaibo, Venezuela.

Q *What fabrication was needed to adapt your rigs for desert operation?*

A Trailer-mounting of all rig components, using 21x25 tires on wheels. Of course, rigs have to be moved to locations where sand dunes are neither too high nor too deep.

Q *Where are your operational headquarters?*

A At Benghazi, eastern capitol of Cyrenaica, which is strategically located near the oil fields. Wayne Burris is general drilling superintendent in charge. The company also maintains an equipment yard in Benghazi, where replacements and spare parts are stored and checked out for each of our six contract rigs and a water-well spudder.

Q *Where is your contract representative located?*

A At Tripoli, western capitol of Tripolitania, Libya. He maintains contact with all operating companies working presently, as well as those planning future operations in Libya.

Q *What are the main operating problems?*

A Transportation and communications. Libya has an area of 679,358 square miles, about two and one-half times the size of Texas, with a population of 1,200,000.

Roads into the interior are generally extremely poor with troublesome deep sand, and rough, rocky stretches. A record high temperature of 136.4° in the shade was recorded at a point south of Tripoli. In spite of these handicaps, modern transportation equipment, including oversize diesel trucks, keeps drilling operations running smoothly. Crews live in self-sufficient camps located adjacent to each of the drilling rigs.

Loffland Brothers' Rig V-55 is shown drilling for Esso Standard (Libya) Inc. in Libya's Concession 6.

Q *Are any of your contract rigs conducting air-drilling or air-coring operations?*

A No. It is understood that studies of these techniques are being made by the operating companies insofar as they might apply to Libyan operations.

Q *Does conventional rotary diamond-coring differ from practices employed in similar drilling areas in the United States?*

A No. Conventional rotary diamond-coring operations are conducted over an interval totaling up to 400 feet for each well. A standard 6⅛-inch O. D. diamond core-head is employed. High recoveries are obtained in both carbonate and sandstone reservoirs.

Q *How is the water problem solved in conventional drilling operations in the Libyan desert?*

A In drilling water well A-217 in Concession 17, crews set a single joint of 10-inch conductor pipe. A 9-inch hole was cut to the top of the first water sand where a string of 7-inch casing was hung. Then the water sand was penetrated using a 7-inch undercutter to the desired penetration of the aquifer.

Depth to water supply ranges from 700 to 1,000 feet.

Penetration depth is determined by (1) geological conditions (2) hydraulic conditions, such as natural flows, pumping rates, drawdown, and (3) rig requirements.

Either one of the two following completion methods is employed in completion of a water well:

1. Set-through and perforate. After well reaches total depth, 7-inch casing is run to bottom and perforated. Perforated interval and shot density is governed by geological conditions, hydraulic conditions and rig requirements.

2. Slotted liner completion. A slotted liner is run inside of the 7-inch casing set on top of the water sand.

In either completion method, a string of 4-inch tubing is run with a 4-inch working barrel. Then, a string of ¾-inch rods is run and a lightweight pumping unit mounted at the surface. A stroke of 40 inches is used for optimum drawdown and hydraulic delivery needs.

The number of water wells drilled on a concession depends upon the following field conditions:

1. Number of drilling rigs served by the particular water well.

2. Hydraulic condition of the aquifer penetrated, sand conditions, drawdown, etc.

3. Size of the concession.

4. Development program anticipated or projected.

5. Transportation methods for moving water from water well to drilling rig, i.e., whether by water line or by tank-truck.

Where tank truck is used, 40-barrel tanks are employed.

Q *What borehole and casing programs do you use in the Libyan desert?*

A The following three tables illustrate some recent experiences of Loffland Brothers Company in the design of

Airplanes play a vital role in African drilling operations. Here an airliner stops at Loffland Brothers' Rig V-26 drilling for Oasis Oil Company in Concession 26 in Libya.

Rig V-34 of Loffland Brothers Company was completing the important Zelten discovery in Libya when this photograph was taken. The location is Concession 6, southwest of Benghazi.

borehole, casing size and casing setting depths for various depth ranges:

String	Hole Size (inches)	Casing Size (inches)	Setting Depth (feet)
Contract Depth: 6,000 feet			
Conductor	24	20	60
Surface	17½	13⅜	2,300 app.
Production	12¼	9⅝	6,000 app.
Contract Depth: 10,000 feet			
Conductor	24	20	353
Surface	17½	13⅜	1,696
Protection	12¼	9⅝	8,500
Contract Depth: 11,555 feet			
Conductor	20	18⅝	63
Surface	17½	13⅜	1,006
Protection	12¼	9⅝	8,500
Total depth	8½		11,555

Q *Do you have any problems with straight-hole drilling?*

A We encountered difficulty maintaining a straight hole in some areas. However, this is not a major problem.

Q *What is the maximum deviation from vertical allowed in the drilling contract?*

A Five degrees, maximum.

Q *How does sand-blowing affect maintenance and replacement of rig equipment? What preventative measures do you employ to minimize sand abrasion?*

A Intense sand storms, which may last up to four hours, are common occurrences in the Libyan desert. The drilling contractor will increase the frequency of changing filters on both oil and air equipment. After a storm has passed, crews change the filters anyway as a matter of maintenance.

Q *What logistics and supplies problems do you have?*

A The matter of logistics has posed an extremely rough problem in the past. You do not purchase supplies locally. Therefore, the oil companies have experienced a terrific supply problem. All supplies, casing, drilling mud, and heavy rig parts are imported; they are brought into the principal ports from which point they are trans-shipped by heavy-duty trucks to each rig and camp. Special emergency small equipment replacement parts are flown in by DC-3 direct to the rig from the supply base.

Q *What is the range of temperatures encountered in day and night drilling in the Libyan desert?*

A Surface temperatures range from 32° to 132° F.

New oil discovery in Libya

Several drillstem tests in a wildcat well on Block 20, held jointly by Libyan-American Oil Company and Esso Sirte, recently indicated substantial volumes of oil and gas. The exploratory well is located in the Sirte Basin about 100 miles inland from the Mediterranean coast and about 70 miles from the nearest production.

Block 20 is immediately north of block 47, the south end of which has been proven for oil production by the concessionaire, American Overseas Petroleum Ltd. Amoseas' Beda 1-47 was completed in September 1959 for 3,650 bpd, API gravity 36.6° from Paleocene calcarenite at 4,100 feet.

The new LibAm-Sirte discovery is also located west of Esso's Zelten field, where prolific Paleocene production has likewise been proven. Although complete details of the new discovery had not been released as of early December, the pay thickness is known to be comparable to the lower zone in LibAm-Sirte's Mabruk field (WORLD OIL, August 15, 1960, Page 152).

France moves to diversify Sahara crude oil markets

New Sahara exploration permits due to attract capital from Italian and West German interests

THE FRENCH GOVERNMENT is trying a new approach to insure diversification of markets for Sahara crude throughout West Europe. The latest group of Sahara exploration permits issued on Aug. 29, 1960, is expected to attract investment capital from several private Italian and West German companies for the first time.

The French interests were granted almost three-fifths of the new concessions of 8,164 square miles which represented 59.8 percent of the total awards. However, non-French interests were awarded 5,477 square miles, representing the remainder of the new concessions granted.

Shell gets most acreage. The principal non-French group represented was Royal Dutch Shell, which gained 2,942 square miles, or 21.6 percent, of the total surface area of the new concessions. Next in importance were the German companies which accounted for 837 square miles, or 6.1 percent. Significantly, two new German companies entered the French Sahara exploration scene on separate structures, but with identical French partners as formerly.

Wintershall A. G., an independent producer and refiner of West Germany together with its identical French partners, FRANCAREP and PETROPAR received the Hassi Mestour permit, which lies in both the Oasis (east) and Saoura (west) regions of the French Sahara for an investment of $1,020,408.

Elwerath Gewerkschaft of Celle, Germany, an independent German producer, received the 1,197 square-mile permit on the Hassi Nechoua area with its French partners, EURAFREP and PETROPAR for an investment of $1,581,633. Both Shell and Esso hold minor interests in Elwerath Gewerkschaft.

Italian companies. The new Italian participation in the recent permits granted totaled 753 square miles, or 5.5 percent of the total area. The three new Italian firms to enter the French Shara exploration scene are the private industrial groups related to the principal Milan firms of Montecatini, Fiat and SNIA VISCOSA.

Together with their French partner, PREPA, they were awarded the Hassi Allal-Erg Sedra permit covering 1,506 square miles, for an investment of $1,989,796.

Frandel, a U.S.-Canadian firm, received a permit to explore the Rhourde Hamra region in the Oasis region. They participate with two French companies, PETRO-

TABLE 1—Distribution of Ownership of 9 New Concession Permits in Algeria Issued August 29, 1960 by the French Government

Name of Company	Permit Region	Surface Area (Sq. Mi.)	Total Investment (Millions $)	Concession Period (Years)
C. P. A. (Shell)	de Lejamate (O)	4,526	6.6	5
Eurafrep, Petropar & Elwerth	Hassi Nechou (O&S)	1,197	1.6	5
Petropar, Francarep, & Frandel	Rhourde Hamra (O)	1,583	2.3	5
Prepa, Petrosuel, OM & Saici	Hassi Allal-Erg Sedra (O & S)	1,506	2.0	5
S. N. P. A.	Demrhat el Acha (O & S)	1,468	1.9	5
S. P. V.	Hassi Izi (S)	309	0.3	(to 9-28-63)
S. N. Repal	Melbrouk (S)	1,699	2.2	5
Francarep, Petropar, & Wintershall	Hassi Mestour (O & S)	774	1.0	5
Safrep	Rhourde el Baguel (O)	579	0.8	5
Totals 9 New Concession Permits		13,641	18.7	

Legend

C. P. A.: Compagnie des Petroles d'Algerie (Royal Dutch Shell Group 65 per cent)
EURAFREP: Societe de Recherches et d'Exploitation de Petrole.
PETROPAR: Societe de Participations Petrolieres.
FRANCAREP: Compagnie Franco-Africaine de Recherches Petrolieres.
FRANDEL: Societe Franco-Delhi S. A. (Canadian).
S.N.P.A.: Societe Nationale des Petroles d'Aquitaine.
S.N. REPAL: Societe Nationale de Recherches et d'Exploitation des Petroles en Algerie.
SAFREP: Societe Anonyme Francaise de Recherches et d'Exploitations de Petrole.
S.P.V.: Societe des Petroles de Valence (British Petroleum 50 per cent).
OMNIREX: Omnium de Recherches et d'Exploitations Petrolieres.
REGION: O: Oasis (East) S: Saoura (West). INVESTMENT: 4.9 N.F. = $1.00 American

TABLE 2—Distribution of Ownership by Interest Groups—9 New Exploration Permits in Algeria (Issued on August 29, 1960 by the French Government)

Interest Group	Surface Area Sq. Mi.	Percent of Total
French Interests	8,164	59.8
Non French Interests	5,477	40.1
Royal Dutch Shell Group	2,942	21.6
German (Elwerath & Wintershall)	8,370	6.1
American-Canadian (Frandel)	776	5.7
Italian Companies	753	5.5
British Petroleum Company	169	1.2
Totals	13,641	100.0

PAR and FRANCAREP, over a surface area of 1,583 square miles, with an investment of $2,301,020. Thus, the U.S.-Canadian participation of 776 square miles represents 5.7 percent of total permits.

Northern Algeria. The first oil concession permit to be issued in Algeria proper since 1954, was granted by the French government in Paris to Societe Nationale de Recherches et d'Exploitation des Petroles en Algeria, on Sept. 5, 1960.

The concession, known as Permis du Cheliff-Tiaret, is located between the cities of Oren and Orleansville. On the northwest it borders on the coastline from the town of Mostaganem southwesterward; on the southeast it adjoins the Taria-Charrier permit held by Compagnie Algerienne de Recherches et d'Exploitations Petrolieres. Surface area is 913 square miles.

A minimum investment of $1,034,694 is required under the terms of the concession which is set up for a three-year term.

Non-French holdings. On Oct. 1, 1960, there were 17 non-French companies operating in the French Sahara with surface holdings totaling 294,432 acres.

Included are eight U. S. companies, i.e., Afropec (Cities Service), Calasiatic (California Asiatic Oil Company), Esso Standard, Pan American International, Phillips Petroleum Company, Newmont Mining Corporation, Sinclair Oil and Gas Co. and Texaco Overseas Petroleum Company.

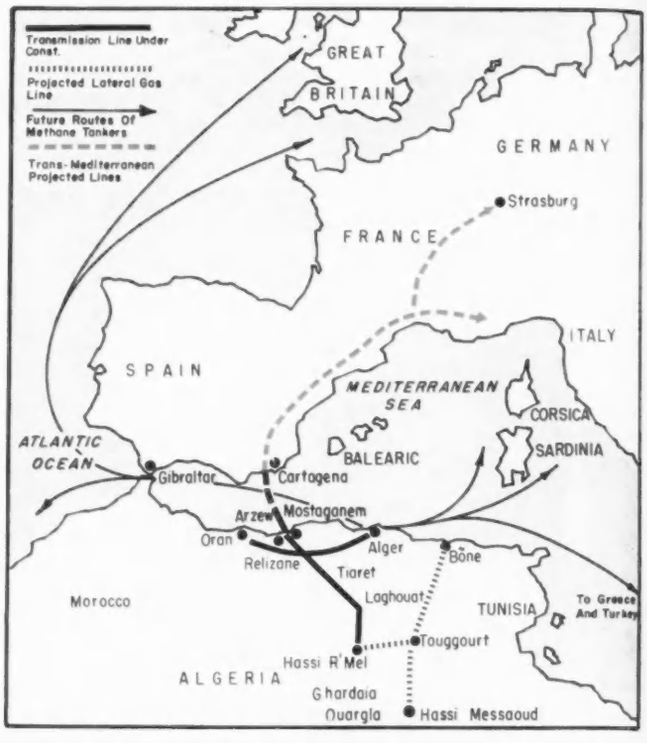
The four German companies include, Deutsche Erdoel Akiengesellschaft, Elwerath Gewerkschaft; Preussische, Gergwerke und Hueten A.G. and Wintershall, A.G. The Italian companies include AMI-Ausonia Mineraria; Fiat, Montecatini, S.P.A., Snia Viscosa.

TABLE 3—Non-French Oil Companies with Oil Concessions in Algeria (Statistics as of May 15, 1960)

Company	Attributable Surface Acreage		
	Sq. Mi.	Percent of Foreign Sub-Total	Percent of Total All Companies
Ausonia-Mineraria	1,890	2.7	0.7
British Petroleum	5,057	7.3	1.8
Caltex	3,066	4.4	1.1
Cities Service	8,182	11.8	2.9
Canadian-Delhi	341	0.5	0.1
Elwerath	48	0.1	....
Mobil	3,218	4.7	1.1
Pan American International	480	0.7	0.2
Phillips Petroleum	2,275	3.3	0.8
Royal Dutch Shell	36,672	53.1	13.1
Sinclair-OVAIM-Newmont	3,426	5.0	1.2
Standard Oil Co. (New Jersey)	3,978	5.8	1.4
Wintershall, A.G.	460	0.7	0.2
Sub-Total French Companies	69,093 211,771	100.0	24.6 75.4
Total Permits Granted in Algeria	727,252	....	100.0

TABLE 4—Distribution of Ownership in Algerian Oil Concessions by Foreign Interests (Status as of May 15, 1960)

Interest Groups	Percent of Total
1. International Groups (Standard, Shell, B.P., Caltex and Mobil)	18.52
2. American Independents	5.23
3. European Independents	0.85
Sub-Total Foreign Interests	24.00



Construction of lines from the Hassi R'Mel and Hassi Messaoud fields to Mediterranean coast, use of methane tankers, a methane liquefaction plant at Arzew, plus four 8-inch gas lines across Mediterranean from Mostaganem to Cartegena in Spain are included in . . .

Plans for moving Sahara gas to European markets

A 120-MILE LONG, $700 million trans-Mediterranean Sea pipe line system to transport gas from Hassi er R'Mel field in the Sahara to Western Europe now is in the planning stage by Societe d'Etudes du Transport du Gaz de Hassi er R'Mel par Canalisation Transmediterranenne. The proposed system consists of four 8-inch lines and runs across the western Mediterranean from Mostaganem, Algeria to Cartagena, Spain.

A 24-inch gas transmission line currently is under construction from Hassi er R'Mel field to the Mediterranean system's proposed starting point at Mostaganem. This line also will supply natural gas demand in northern Algeria. Big-inch transmission lines are planned from the Spanish terminus of the submarine system to France, Belgium, Switzerland, Luxembourg and Germany.

Hydrographic work indicates maximum water depth to be 8,858 feet. Anticipated engineering construction problems are being studied.

Total capacity of the submarine system is estimated at 960 MMcfd. This is the approximate energy equivalent of one-eighth of the present total annual coal output of Europe.

No construction date for the submarine system has been announced.

French companies are planning construction of a methane liquefaction plant at Arzew, Algeria.

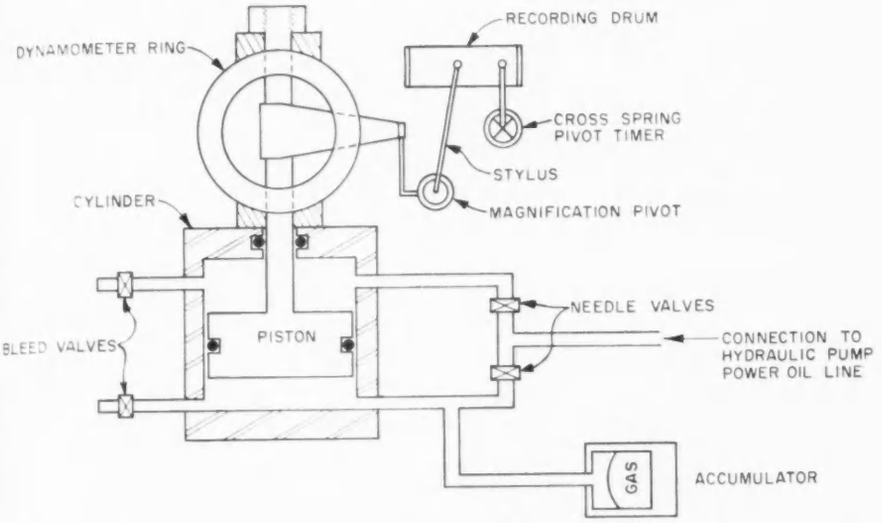


FIGURE 1—The hydraulic dynamometer consists of a ring type dynamometer in series with a piston in a hydraulic cylinder. When hydraulic pressure is applied to the cylinder, the resulting force on the piston is transmitted to the dynamometer ring and thereafter recorded on a chart. A cross spring pivot timer measures the chart speed. The piston in the load cell is balanced in such a manner as to reflect the pressure change due to operation of the bottom hole hydraulic pump.

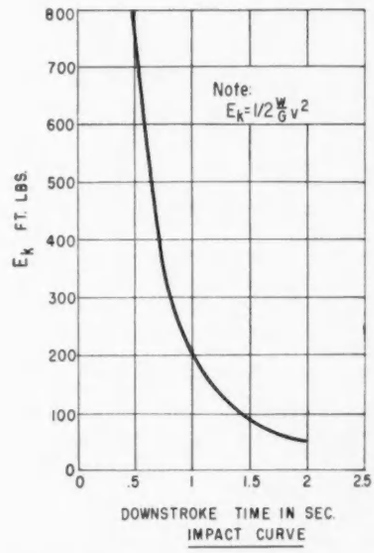


FIGURE 2—Plot shows relationship between kinetic energy and downstroke time. Downstroke time should range from one-two seconds to prevent excessive impact loads which can cause pump failure.

How to improve your hydraulic pumping operations

Correct analysis of hydraulic dynamometer cards can improve efficiency, boost production

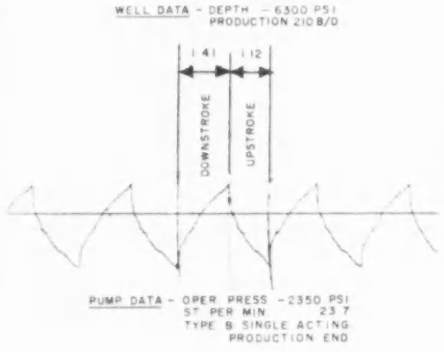
By John B. Woods, Chief Engineer
Johnson-Fagg Engineering Company, Tulsa, Okla.

PROPER INTERPRETATION of hydraulic dynamometer cards can improve operational efficiency of hydraulic pumping installations. Since the dynamometer provides a record of pump strokes and a count of actual strokes per minute, accurate computation of pump volumetric efficiency is possible. This article discusses use of the device and includes interpretations of actual cards obtained in the field.

Unlike the polished rod dynamometer which is used to "weigh" beam pumping wells, the hydraulic dynamometer records pressure variations. The unit is actually a sensitive pressure recording instrument which includes a timing element. Figure 1 shows component parts of the hydraulic device.

How it operates. The first step in operation is to introduce triplex pressure into the instrument manifold and expose both top and bottom side of the load cell piston to this pressure. The total force on each side of the piston then is balanced and the valve leading to the bottom of the piston is closed.

A hydraulic pneumatic alleviator with a nitrogen charged diaphragm is in the fluid circuit below the piston to provide the necessary "spring" action. Since the piston is balanced,



PUMP DATA

Strokes Per Minute = 23.7
Operating Pressure = 2350
Size 2 × 1⅜ × 1¼ × ⅜ × 49
Orifice = 7/32 = .0376 Sq. In.

WELL DATA

Depth = 6300 Ft.
Production = 210 B/D
Wt. Production Fluid = 2595 PSI
Wt. Power Fluid = 2320 PSI

$\frac{101.63}{68.0}$ = 1.495 Sec. for Downstroke Time

1.410 Sec. Actually Measured

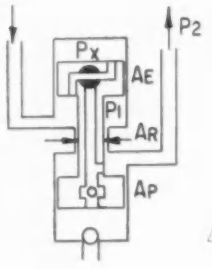
FIGURE 3—Card of a single acting pump with a controlled downtroke and with full loading on the production end shows proper operation. Note similarity of calculated and measured downstroke time.

PUMP DATA

Strokes per min. = 21.9
Triplex Pressure = 3500 psi
Size 2 × 1⅜ × 1¼ × ⅜ × 49
Orifice = 3/16" = .0276 Sq. In.

WELL DATA

Depth = 10,000 ft.
Production = 50 bbl water — 47 oil
Pump end Efficiency = 55.7%
Wt. Production Fluid .362 psi/ft = 3620 psi
Wt. Power Fluid = .35 psi ft. = 3500 psi



A_E = Area Engine Piston = 2.074 sq. in.
A_R = Area Middle Rod = .358 sq. in.
A_P = Area Pump Piston = 1.227 sq. in.
P_T = Triplex Pressure = 3500 psi
P_1 = Pressure under engine piston = P_T + weight power fluid
P_2 = Weight production fluid
P_X = Pressure above engine piston to establish equilibrium of forces on piston assemblies while pump is on downstroke

DOWNSTROKE ALL FLUID UNDER PUMP PISTON

$\uparrow P_1 (A_E - A_R) + A_R(P_2) = P_X (A_E) \downarrow$

$7000 (2.074 - .358) + .358 (3620) = P_X (2.074)$

$P_X = 6380$ psi

$\triangle$ P Below and Above engine piston = $P_1 - P_X = 7000 - 6380 = 620$ psi

$V = 7.944 \sqrt{\triangle P} = 7.944 \sqrt{620} = 196$ ft/sec
$= 2350$ in./sec.

$Q = VA = 2350 (.0276) = 64.8$ cu. in./sec.

Amount of fluid to flow through orifice = $2.074 \times 49 = 101.63$ cu. in.

$\frac{101.63}{64.8} = 1.566$ sec. for Downstroke

DOWNSTROKE NO FLUID UNDER PUMP PISTON

$\uparrow P_1 (A_E - A_R) = P_X (A_E) + P_2 (A_P - A_R) \downarrow$

$7000 (2.074 - .358) = P_X (2.074) + 3620 (1.227 - .358)$

$P_X = 4280$ psi

$\triangle$ P Below & Above engine Piston = $P_1 - P_X = 7000 - 4280 = 2720$ psi

Velocity = $7.944 \sqrt{\triangle P} = 7.944 \sqrt{2720} = 414.0$ ft/sec.
$= 4960$ in./sec.

$Q = VA = 4960 (.0276) = 137.0$ cu. in./sec.

Amount of fluid to flow through orifice = 101.63 cu.in.

$\frac{101.63}{137.0} = .742$ sec. for Downstroke

Downstroke time no fluid = .742 sec.
Downstroke Time all fluid = 1.566 sec.
Pump End Efficiency = 55.7%

.557 (1.566) = .872
.443 (.742) = .328
1.200 Theoretical downstroke time

1.370 — Actual downstroke time

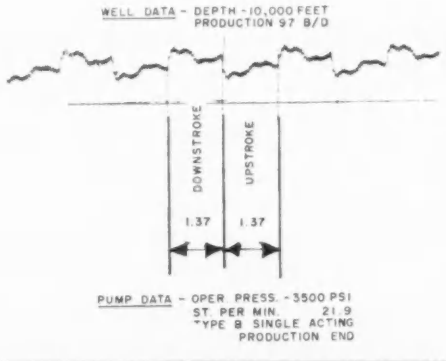


FIGURE 4—Here is a complete sample calculation for a dynamometer card taken on a single acting pump completely filled and fully cavitated.

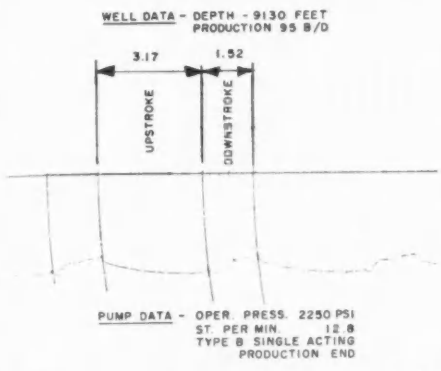
it is sensitive to small pressure changes. This means that total pressure is not measured, but only the small pressure impulses resulting from pump operation.

The only required well connection is a ¼-inch pipe outlet in the power oil side or production side of the system. Best results can be obtained by taking the card at the wellhead. If the card is taken at a central manifold, triplex vibrations may make interpretation difficult. An example of triplex impulses is shown in Figure 7A. Impulses have been damped out at the left of the card by partially closing the needle valve in the circuit to the top side of the piston.

Pump cavitation is the most common cause of inefficient operation. This is evident when it is realized that only a small percentage of pumping wells operate with a high pump efficiency. In the majority of cases, pump displacement is greater than the well's ability to produce and cavitation or a partial filling of the pump barrel results.

When cavitation occurs in a single acting hydraulic pump, downstroke velocity is dominated by the weight of the column of fluid on the pump plunger. In double acting pumps, both upstroke and downstroke become rapid when cavitation occurs in the production end of the pump.

Excessive pump piston velocities resulting from cavitation cause failure of pump parts due to impact. The



PUMP DATA

Strokes Per Minute	= 12.8
Operating Pressure	= 2250 PSI
Size = 2½ × 2 × 1½ × ⅜ × 66	
Orifice — ¼" = .0491 Sq. In.	

WELL DATA

Depth	= 9130 Ft.
Production	= 95 B/D Oil
Pump End Efficiency	= 41.7%
Wt. Production Fluid	= 3380 PSI
Wt. Power Fluid	= 3380 PSI

1.734 Theoretical Downstroke Time
1.520 Actual Downstroke Time

FIGURE 5—Card of single acting pump in gassy well shows downstroke pressure slightly higher than upstroke pressure. Downstroke time is within safe operating limits.

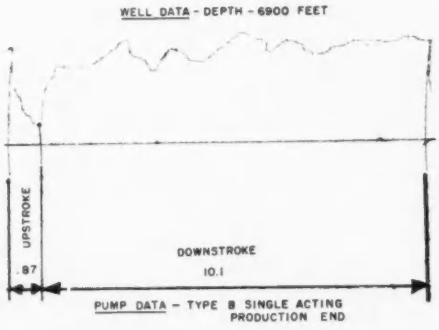
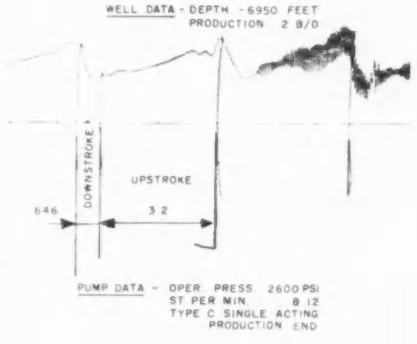
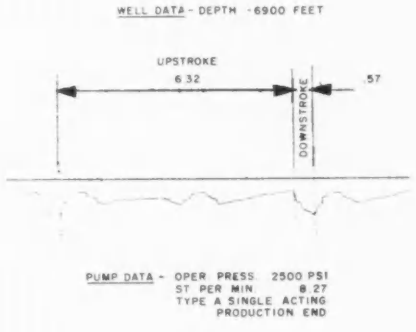


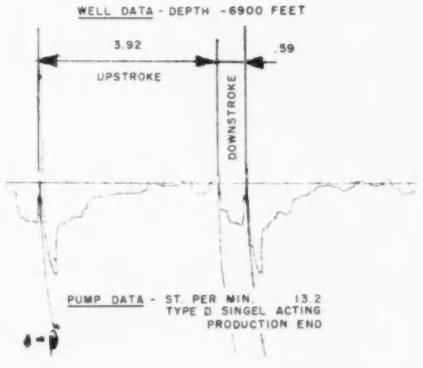
FIGURE 6—This card shows the wide downstroke control possible with some types of single acting pumps. Note time of 10.1.



A



B



C

CARD 7A

PUMP DATA

Strokes Per Minute	= 8.12
Operating Pressure	= 2600 PSI
Size 2½ × 1¾ × 1½ × ⅜ × 58¾	
Orifice Two 3/16 Holes — No Control	

WELL DATA

Depth	= 6950 Ft.
Production	= 2 B/D
Wt. Production Fluid	= 40° Gravity
	= 2480 PSI
Wt. Power Fluid	= 2480 PSI

$\frac{141.5}{247}$ = .573 Sec. Downstroke Time

.646 Sec. Actual Downstroke Time

FIGURE 7—These cards were taken on three single acting pumps in the same field made by three different manufacturers. Pressure drop on downstroke is caused by high piston velocity. Figure 7A shows how triplex impulses can affect card.

kinetic energy involved varies as the square of the velocity and directly as the mass of the moving part. Figure 2 is an impact curve showing the relationship between kinetic energy and time for the downstroke which is a measure of average piston velocity. To prevent drastic impact loads, downstroke time should be in the one-two second range.

Analysis of the accompanying dynamometer cards and calculations show that downstroke time in a single acting pump has a definite relationship to the fluid volume in the pro-

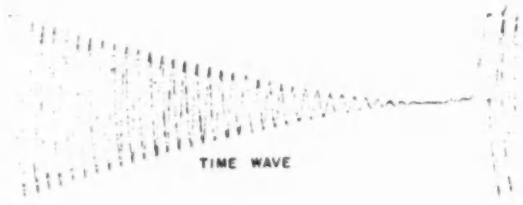
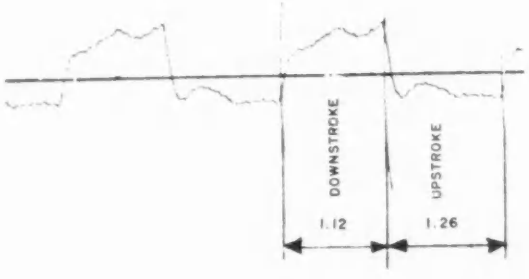


FIGURE 8—Single acting controlled pump operating in pumped-off condition still exhibits good downstroke control although no fluid exists below the plunger on the downstroke.

WELL DATA - DEPTH - 6900 FEET

PUMP DATA - OPER. PRESS. 2700 PSI
ST. PER MIN. 25.2
TYPE B SINGLE ACTING
PRODUCTION END



PUMP DATA	WELL DATA	
Strokes Per Minute = 25.2	Depth	= 6900 Ft.
Operating Pressure = 2700 PSI	Production — Pumped Off	
Size = 2 × 1⅛ × 1¼ × ⅜ × 60	Wt. Production Fluid	= .36 PSI/Ft.
Orifice 3/16		= 2480 PSI
	Wt. Power Fluid	= 2480 PSI

$\frac{124.44}{115.5}$ = 1.08 Sec. Downstroke Time

1.12 Actual Downstroke Time

duction end. This relationship also can be shown theoretically. Calculations show the method used and the close correlation between theoretical and measured downstroke times.

Figure 3 shows a card of a single acting pump with a controlled downstroke and with full loading on the production end. In analyzing a card on this type pump, the first step is to determine upstroke and downstroke. The points of turn around must be picked out to measure strokes per minute and downstroke time. The ability to do this comes with experience. However, it is fairly easy on a controlled single acting type of pump as the downstroke generally begins with an increase in pressure and the upstroke always begins with a drop in pressure.

Chart speed can be taken from the timing wave (timing bar vibrates at 7½ cycles per second) and time can be measured between any two points on the card. An accurate count of strokes per minute can be made and downstroke time can be checked to be sure that piston velocities are within reasonable operating limits. The dynamometer card should be checked for constant repetitive pump stroking. Should any irregularities occur, such as pump sticking, the position of the stroke where sticking occurs provides a clue to analysis of the pump trouble.

Calculations in Figure 3 and subsequent cards show how calculated downstroke time agrees with that actually measured.

Figures 4 and 5 show cards of controlled single acting type pumps operating in gassy wells. However, the general style of card is the same as in Figure 3. Downstroke pressure is slightly higher than upstroke pressure and downstroke times are well within safe operating limits.

A full sample calculation is made in Figure 4 for two conditions. The first with the pump completely filling with no cavitation and the second with the pump fully cavitated. Production tests on this well show 55.7% pump end efficiency. This means that the pump is cavitating 44.3%, resulting in total theoretical downstroke time of 1.200 seconds. Actual measured downstroke time was 1.370 seconds.

Figure 6 shows that downstroke control is possible to any degree in some types of single acting pumps. Note the 10.1 second downstroke time.

Figure 7 shows cards of three pumps made by three different pump manufacturers. All three are operating in the same field, and the operator desires to produce all available fluid. Stroke lengths vary from 60-65 inches. All three pumps are single acting type with no downstroke velocity control. Note the close correlation of downstroke times. Also, note the drop in pressure on the downstroke on all charts. This is caused by high piston velocities.

Figure 8 shows a single acting controlled pump operating in a "pumped-off" condition. The card is representative of this type pump. Also, note the controlled downstroke even though no fluid exists below the production plunger on the downstroke.

Dynamometer readings also have been taken on double acting pumps. In one case, readings were taken during normal operations. The well was shut in for 24 hours and after start-up, dynamometer readings were taken at regular intervals until well conditions again returned to normal. The last card was identical in shape to the original. Thus, it seems apparent that cards on double acting pumps reflect actual well conditions.

Dynamometer studies of hydraulically pumped wells have proved valuable in improving pump design and operation. Such studies are in their infancy, and it is felt that progress in the field of hydraulic pumping will depend much on the use of the dynamometer and similar types of instrumentation. —The End

Tyler sand trend becoming better known in Dakotas

Basal Pennsylvanian age of Tyler appears firmly established; oil traps mainly stratigraphic

By Frank W. Foster
Consulting Geologist
Bismarck, N. D.

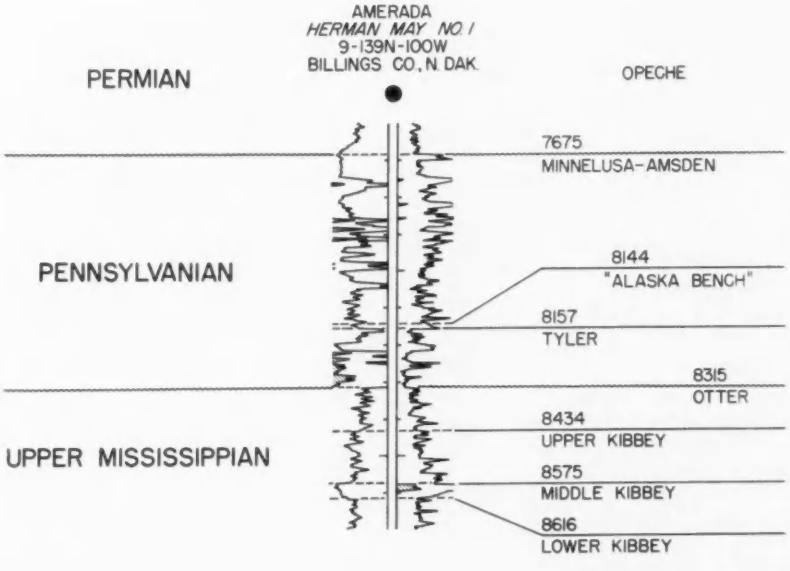
SAND LENSES IN BASAL PENNSYLVANIAN SEDIMENTS are important sources of oil in southwestern North Dakota and central Montana. Basal Pennsylvanian beds in the Williston Basin are shales, sands and thin limestones overlying the upper Mississippian Otter formation (Figure 1) and older Paleozoic strata; and underlying Permo-Pennsylvanian Minnelusa-Amsden carbonates in the Williston Basin portion of the Dakotas.

McCauley,[1] Harris,[2] and Willis[3] have contributed much to the literature on these sediments. The strata discussed herein are called the Heath formation and were dated previously as Mississippian. This formation is now considered to be Pennsylvanian in age. This idea is widely accepted. The stratigraphic nomenclature committee of the North Dakota Geological Society proposes that the name Tyler (taken from the basal Pennsylvanian of central Montana) be applied to these strata.

Figure 1 shows similarities to central Montana terminology—i.e., the Alaska bench member of the Amsden and the underlying "Tyler formation," which here rests on the Otter formation of the Mississippian Big Snowy group.

Unconformity and related sediments. Local and regional stratigraphy, lithologies, petrography and paleontology support the idea that the Tyler rests on an unconformity (Figure 2). At least part, if not all, of the rocks shown on this cross-section have been called Heath in the past. If any Heath remains in North Dakota, the author believes it is represented by eroded, dissected remnants illustrated as "basal detritus" (Figure 2).

Cores cut in the base of the Tyler, some of which have penetrated the Otter, have revealed a shale-sand conglomerate, composed of pebble-size fragments of black Heath-type shale, and some green Otter-like fragments



UPPER MISSISSIPPIAN & PENNSYLVANIAN NOMENCLATURE
WILLISTON BASIN

FIGURE 1—Posted portion of log of Amerada Petroleum Corp. Herman May 1, Billings County, North Dakota, shows position of Tyler formation above post upper Mississippian unconformity.

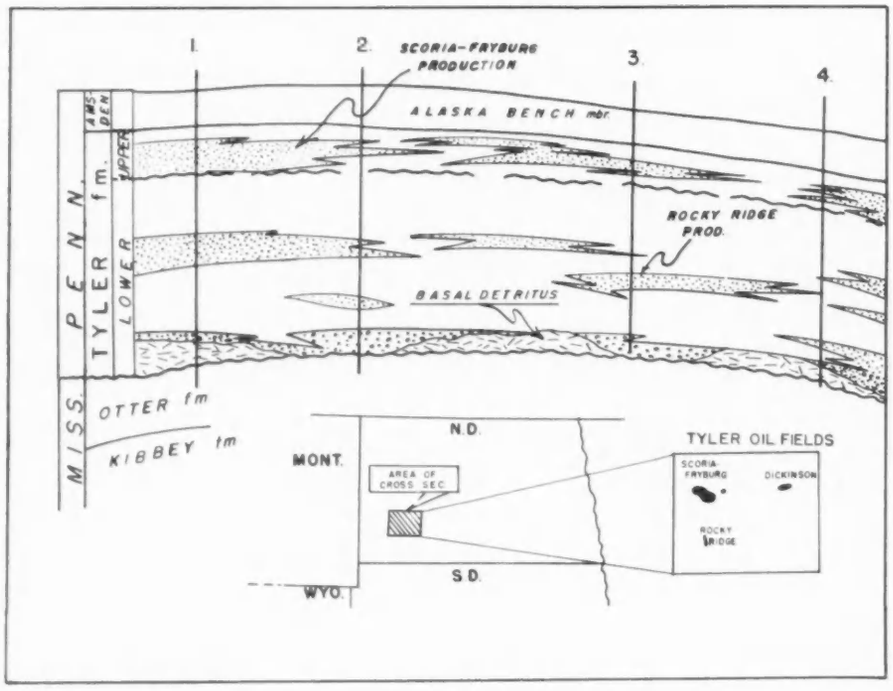


FIGURE 2—Cross-section of upper Carboniferous beds in the Tyler oil field area, southwestern North Dakota, shows local variations of strata covering unconformity.

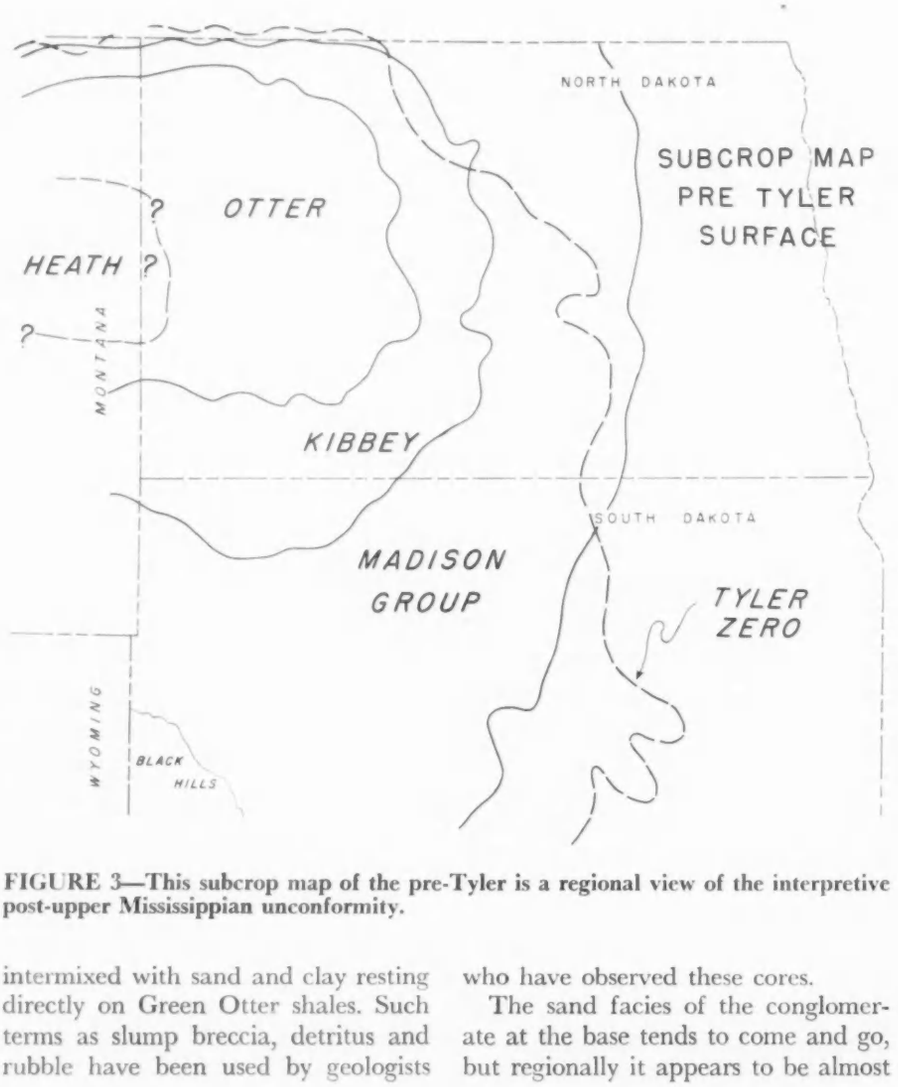


FIGURE 3—This subcrop map of the pre-Tyler is a regional view of the interpretive post-upper Mississippian unconformity.

intermixed with sand and clay resting directly on Green Otter shales. Such terms as slump breccia, detritus and rubble have been used by geologists who have observed these cores.

The sand facies of the conglomerate at the base tends to come and go, but regionally it appears to be almost universally present on various older strata. Harris' petrography in the Rocky Ridge field[2] says this deposit and other sands in the Tyler are reworked from an older sand formation, perhaps the Kibbey.

Fossils from a core near the top of the lower zone in Rocky Ridge (well 3, Figure 2) were fresh water ostracods of early Pennsylvanian age which correlate with the Tyler section in Montana.[4]

Wells 1 and 2, Figure 2 are typical of the Scoria-Fryburg field. Well 3 is typical of Rocky Ridge field and well 4 represents Dickinson field. Regional aspects of the unconformity are shown on Figures 3 and 4.

Figure 3 illustrates the surface on which the Tyler was deposited. The cross-section (Figure 4) shows Mississippian sediments below the unconformity as they were folded into the east-west trending Big Snowy- Williston Basin trough. The map shows their subcrop after truncation by regional erosion at the close of Mississippian time. The dashed Heath line (Figure 3) indicates this formation may extend farther into North Dakota than shown.

The Tyler apparently is part of Pennsylvanian sediments deposited on truncated Mississippian and older sediments to overlap these strata outside of the old Big Snowy trough. This distribution in the Williston Basin is indicated by the zero line of the Tyler on Figure 3. The Tyler is illustrated resting on the Sioux uplift by the curves on the zero line in South Dakota.

Sands as thick as 300 feet occur locally on the Kibbey subcrop and overlap onto the Otter. Wherever these sands lie on Kibbey sand and where they are overlain by Jurassic or Triassic sands, e.g., point 1 on Figure 4, the positions of Pennsylvanian contacts are indistinct. If these sands are mainly basal Pennsylvanian, located as they are on and adjacent to the Kibbey subcrop, the Kibbey was perhaps the primary source of sand in the Tyler. Harris' petrography[2] says possibly so. Willis' petrography in Montana[3] says probably not.

Stratigraphy. The Alaska bench member of the Amsden is shown on Figure 4 overlying the Tyler. Distribution of the Alaska bench limestone is fairly well outlined by the zero line of the Otter on the map. It is a dark brown to black ostracodal dense argillaceous limestone at the base of the Amsden.

In the Dakotas, as in central Montana, the Tyler can be divided in two parts: a lower, mainly black unit, and an upper, mainly red unit (Figures 2 and 4).

The lower unit is predominantly black to dark gray carbonaceous shale, with fresh water ostracods and other fauna; leaves, stems and spores; and pyrite and detrital mica. Thin coal beds are found in the shale. Coal also occurs as angular fragments in shale conglomerates and in sand lenses. Locally, green and dull red shales are present; these colors are also mottled on black shales. Also present are irregular interlaminations of thin fine sand streaks in shale. These fine sand streaks may be all that is left of a porous 30-foot oil-saturated sand lense one well location away.

In South Dakota the lower unit has some green shales, thin dark colored limestone beds and sandstone streaks with a widespread sandstone at the base. This is the Fairbanks sand described by McCauley[1] and others. Lithologies of these sediments suggest these strata are detrital and were deposited by rather rapid sedimentation in a shallow fresh water lagoonal environment and/or in channels.

Sand lenses in the lower Tyler in North Dakota contain fine- to medium-grained subrounded to subangular sand with some calcareous cement. Color is gray to white. The lenses are discontinuous and unpredictable. In any given area, one well may encounter four or five separate sand bodies; another may have one or none.

The upper Tyler in North Dakota is a variable sequence of dull red, brick red, yellow, green and black shale with thin-bedded, tan-brown limestone in some places. Sand lenses occur in one or two discontinuous beds. The sands are white to gray with red and yellow staining in places. In southwestern North Dakota this unit is thin or absent, but northward from about point 3, Figure 4 the interval thickens to as much as 150 feet and is mainly dull red shale. This shale is often called lower Amsden.

It appears that an intraformational unconformity or diastem separates the upper unit from the lower in the

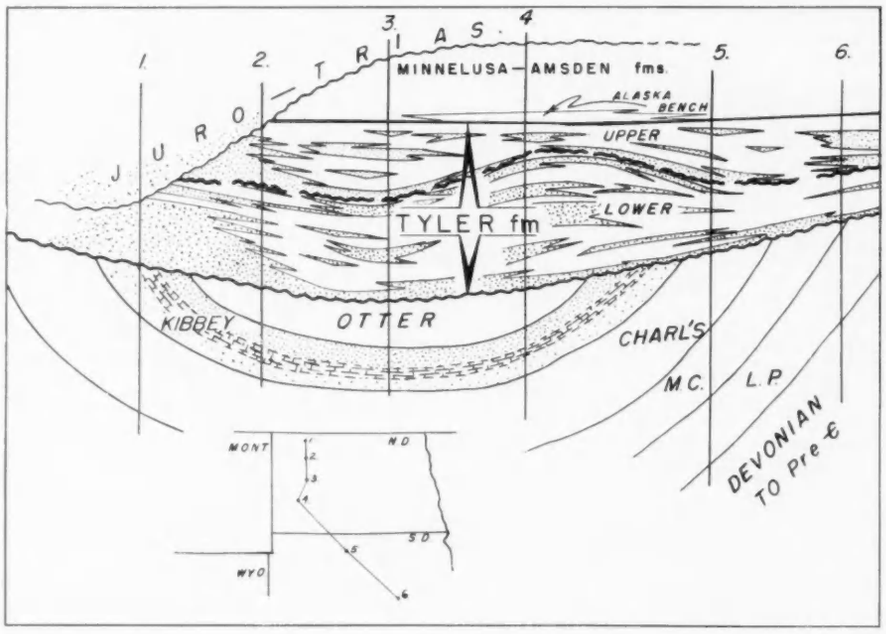


FIGURE 4—This regional cross-section of the Williston Basin shows upper Paleozoic stratigraphic relationships, particularly in Carboniferous beds.

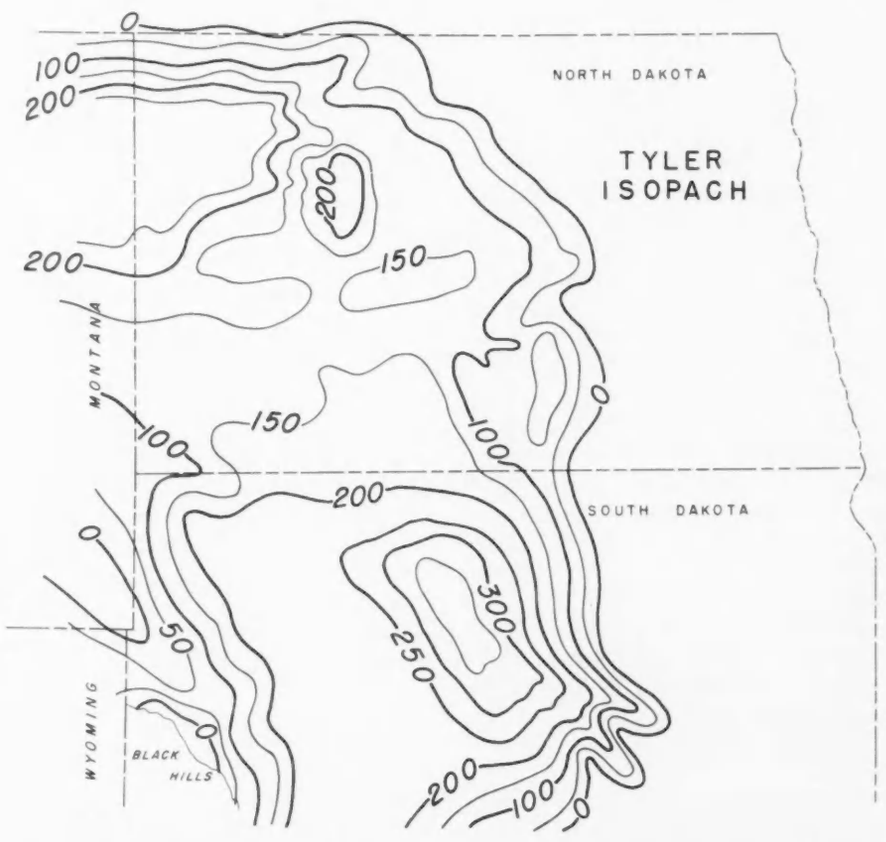


FIGURE 5—Tyler isopach shows maximum thickness of more than 300 feet in South Dakota. Formation is thinned to zero by erosion in north and east and in the Black Hills.

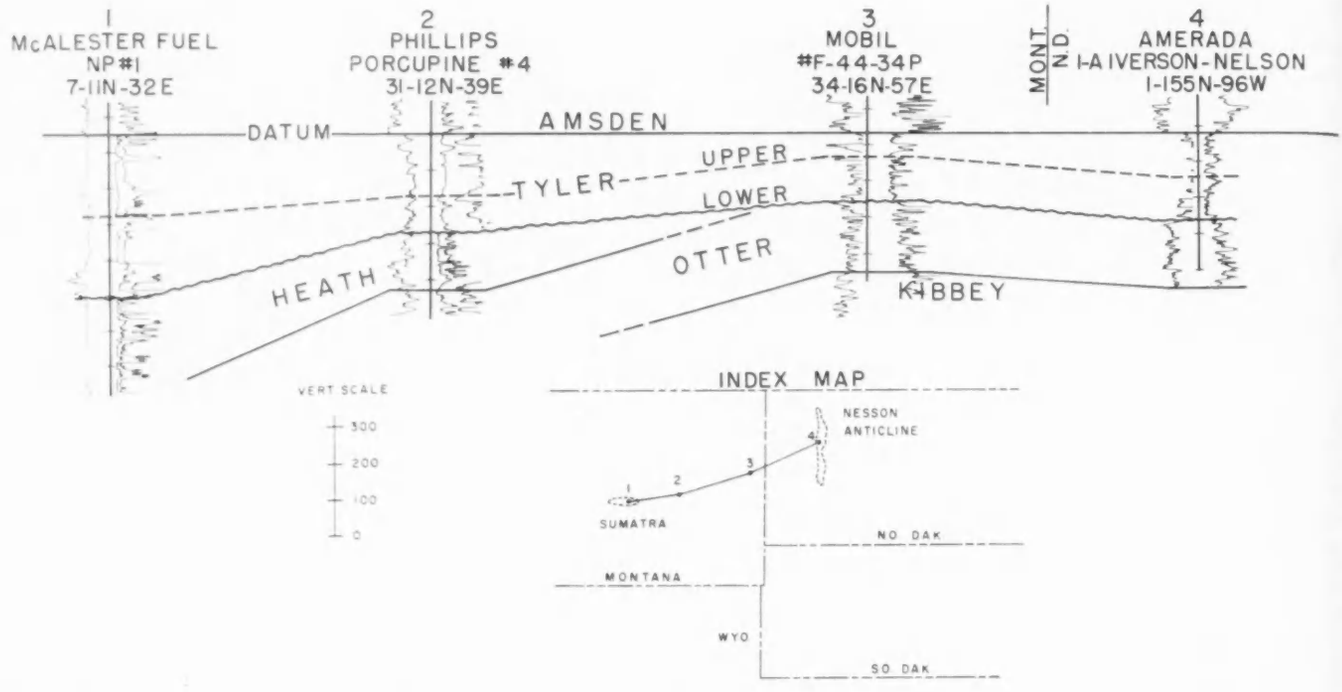


FIGURE 6—This regional cross-section from Sumatra field, Montana to the Nesson anticline in North Dakota shows correlations of Otter, Heath, Tyler, and Amsden formations.

Williston Basin as in central Montana. Much more work should be done to identify these two divisions of the Tyler in the Williston Basin. At this time, the author is not ready to apply the member names Cameron Creek and Sacajawea to these units as Willis[3] has done in Montana.

Toward the zero line (Figure 5) in North and South Dakota colors are predominantly red, with green and yellow in minor amounts. Erosion truncated Minnelusa-Amsden and Tyler formations. This truncated edge is also shown on Figure 4 from point 2 to north of point 1. The cross-sectional picture is similar throughout the truncated edge from the north around to the east. Basal Pennsylvanian sediments may have extended much farther eastward and northward and may be represented by remnant outliers. The thick sand deposits mentioned earlier may be remnants of deltas from which sand winnowed out to the west across early Pennsylvanian mud flats, lagoons and swamps. This concept is premature, but such thick sands excite the imagination of the oil seeker.

Environment. From Figure 5 it appears that the Tyler in North Dakota was developed on a relatively flat shelf, whereas in South Dakota a basin influenced deposition. There, the Tyler, often sand, is up to 350 feet thick. The Tyler in North Dakota has a relatively constant thickness (about 150 feet).

It appears that wherever the thickness exceeds about 200 feet, the upper Tyler zone is well developed; if less than 200 feet, a very thin upper zone may be present. This is true also as correlations are followed westward across the Cedar Creek Pennsylvanian ridge and into the deeper area of central Montana.

Regional history. It appears the Williston Basin area became slightly emergent toward the close of Mississippian (Heath) time. Widespread erosion removed most, if not all, of Heath sediments from the area, ex-

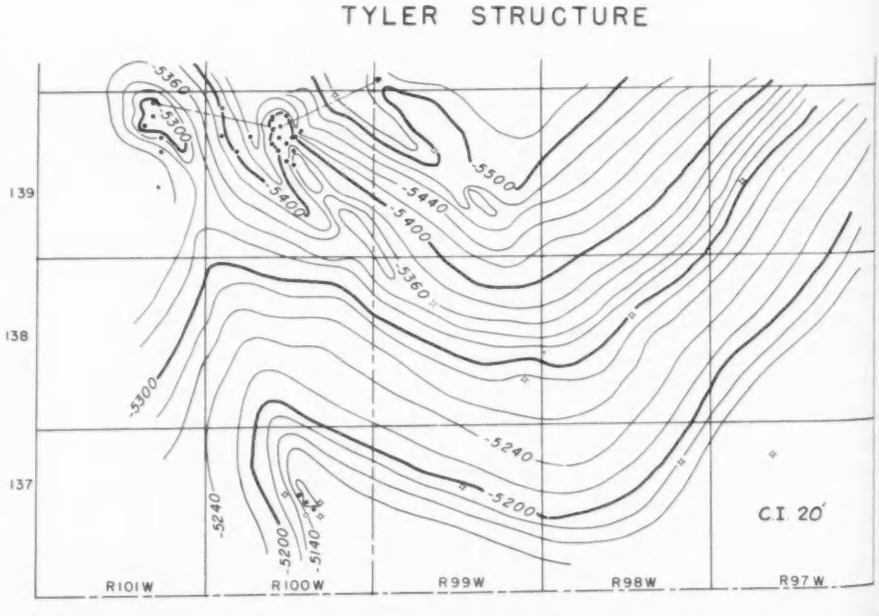


FIGURE 7—This is a subsurface structural map showing the Scoria-Fryburg-Rocky Ridge oil fields area of southwestern North Dakota. Structure apparently controls oil accumulation, to a minor extent, in this area.

posing Otter, Kibbey and older formations. As the Pennsylvanian period opened, Heath remnants were all or in part reworked, and redeposited in a Pennsylvanian environment on an almost flat terrain.

Early Pennsylvanian sedimentation involved the reworking and redeposition of eroded older sediments composed of black shales, coal beds and sand lenses. The area was slightly emergent—a broad flatland of sluggish streams, lagoons, and steaming humid Pennsylvanian jungles.

An interruption occured during this process and local areas began to sink. Apparently, climate changed or the source of the sediments changed, as described by Willis[3] in Montana. In these slowly sinking shallow basins, deposition of red shale beds created the upper Tyler in the Williston Basin and in central Montana. In South Dakota fossils show that marine water invaded the area, and the green and red shales and dark limestones were deposited. The areas that failed to sink were eroded or received a thin mantle of the new environmental deposits.

Correlation of the Dakotas with central Montana. Is the Tyler section in the Williston Basin correlatable with the Tyler of central Montana? Figure 6 shows that sediments which overlie the Mississippian unconformity and underlie the Pennsylvanian carbonate section apparently can be stratigraphically correlated. Note also that upper and lower units carry through.

As to paleontology, Dr. G. O. Raasch and Grace Stewart[4] have examined fossils from at least 17 wells distributed over central and eastern Montana and the Dakotas, and have concluded that fossils which are from both the upper and lower units are mainly fresh water forms of early Pennsylvanian age, Morrow, Atoka or Des Moines. Love and Condra (McCauley[1]) place the lower unit in South Dakota in the same age bracket, with some reservations.

Fossils show the upper unit to be partly marine and partly non-marine, but all of early Pennsylvanian age. The ostracod *Cyprodopsis fabulina* is Dr. Raasch's key fossil, which he concluded is a fresh water form of early Pennsylvanian age. Other fauna and flora support this conclusion.

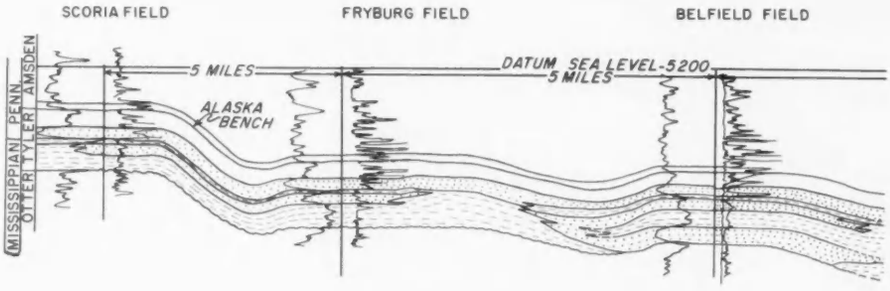


FIGURE 8—Oil accumulation is affected more significantly by lensing of Tyler sands in southeastern North Dakota than by structure, as indicated by this cross-section.

Southwest North Dakota. Subsurface studies indicate that oil accumulation in the Tyler in the Scoria-Fryburg-Rocky Ridge oil fields area is both structurally and stratigraphically controlled, but *primary control is stratigraphic.* Small anticlines and noses (noses may be both anticlinal and synclinal) revealed by 20-foot contours on the top-of-Tyler datum indicate partial structural control of oil production. Structures are of Tertiary age and can be recognized on the surface.

In the Scoria-Fryburg field production is from the upper sand, although oil has been recovered from the next lower sand. This sand is the approximate equivalent of the Rocky Ridge oil sand.

In the Rocky Ridge field good production occurs along a narrow straight trend—perhaps a ribbon sand or small lenses on a larger structure. Attempts to find the producing sand beyond the present field have been unsuccessful.

Good oil staining has been found in cores and samples from the Tyler sands in the southern Nesson anticline area, perhaps the location of the next Tyler oil field. The Tyler is well distributed throughout western North Dakota and is composed of shales which resemble good oil source beds. Many oil fields must be awaiting discovery.

The author acknowledges generous help from the American Stratigraphic Company, Northwest Geological Service and personnel of the Mobil Oil Company, Sinclair Oil Company and The Ohio Oil Company.

This article is based on a paper presented at the Rocky Mountain Section meeting of The American Association of Petroleum Geologists, Billings, Mont., Feb. 10, 1960.

About the Author

Frank W. Foster is a consulting geologist in Bismarck, N. D. He attended public schools in Boulder, Colo., and obtained his Bachelor's degree from the University of Colorado in 1942. After World War II military service Foster returned to Colorado University for two years of graduate work. In 1947 he joined the U.S. Geological Survey in Denver. During 1949-51 he was employed by Lion Oil Company in the Denver office. From 1952 to January 1958, Foster worked for The Ohio Oil Company.

LITERATURE CITED

[1] McCauley, V. T., "Pennsylvania and lower Permian of the Williston Basin," First International Williston Basin Symposium. Saskatchewan Geological Society and North Dakota Geological Society 150-164 (1956).

[2] Harris, S. H., "Rocky Ridge Pool, Billings County, North Dakota." Second International Williston Basin Symposium, Saskatchewan Geol. Soc. and North Dakota Geol. Soc. 40-46 (1958).

[3] Willis, R. P., "Upper Mississippian—lower Pennsylvanian Stratigraphy of Central Montana and Williston Basin," American Association of Petroleum Geologists Bulletin 43, No. 8, 1,940-1,966 (1959).

[4] Personal communication from C. A. Balter regarding paleontology reports from Dr. Gilbert O. Raasch and Grace Stewart to American Stratigraphic Company.

BIBLIOGRAPHY

Foster, D. I., "Northwest Sumatra Field," Billings Geological Society Guidebook, Seventh Annual Field Conference, 116-123 (1956).

FIGURE 1—Inspector and an assistant using magnetic particle inspection method to check a mast to assure sound welding. The suspected weld or area is magnetized by holding prods at each end. Magnetic particles then are gently blown over the surface or flowed on in a liquid suspension. Faulty welds often can be discovered even in cases where surface paint has not yet been broken.

Magnetic particle inspection pays off

Scheduled inspection of welds in mast and related drilling equipment often reveals surprising number of potential failures; will pay for itself times over

By Walter A. Henkes, Manager, Commercial Inspection, Magnaflux Corporation, Los Angeles

A REDUCTION in over-all cost of operations, plus an increase in the safety factor on drilling masts, tools, subs and drill pipe threads and related equipment has been attained by numerous oil companies and contractors since their adoption of routine magnetic particle inspection as a preventive maintenance tool.

The value of such a program becomes apparent when rig failures, infrequent though they may be, occur as a direct or indirect result of weld failures due to propagation of incipient fatigue cracks, most of them invisible to the naked eye. Typical of one actual case that was not caught in time is that of a drilling mast which fell when it was being erected. To ascertain the cause or causes of the failure, a magnetic particle inspection was made. Some 56 cracks were detected in the welds throughout the mast, a high percentage of them being located in the higher stressed members. Most of the cracks were invisible to the naked eye. Marked with crayon, (Figure 2) the defects were eliminated by grinding, the areas re-welded and the welds re-inspected.

Weld inspection pays off. A 96-foot portable drilling mast, base and sheaves were examined and 109 indications of defective welds were observed. Of these welds, approximately 40 percent were due to fatigue. The remaining defects were attributed to poor bond and improper penetration. The majority of the defective welds were located in the lower section. Five were located in the base of the mast. Of the six crown sheaves inspected, two were found to have serious horizontal cracks in the grooves. In addition, one sand line sheave had serious horizontal line track cracks. All three sheaves were retired from service. The

defective welds in the mast and base were eliminated by flame gouging and rewelding.

The usual procedure for inspecting drilling masts is to have them laid out and extended on blocks (Figure 3). However, in many cases, such as on light rigs and truck mounted production hoist masts, inspection can be done without removing them from the vehicles. The next step is to have them steamcleaned, followed by sand-blasting.

Faulty welds easily detected. Inspection by the magnetic particle method is performed in a fundamentally simple manner. A part of the area, as in a mast weldment, is magnetized by holding prods at each end of the suspected section, and employing a high amperage, low voltage controlled electrical source to create the magnetic field between them (Figure 1). A larger section or cluster of welds may be magnetized by the use of clamps. Magnetic particles then are gently blown over the surface, or flowed on in a liquid suspension. The magnetic particles are attracted and held by the magnetic poles at any discontinuity in the part or area, either at or near the surface. The line of powder particles thus built up on the surface marks the defect. The line will show up even on defects wherein the surface paint has not yet been broken. Depending upon metal thickness, cracks existing on the under side of the part may be detected from the top side. Inspection work may be done in either day time or at night. Upon finding a defect the inspector marks the area with a colored crayon or paint. The faulty weld is flame-gouged, ground or chipped out and rewelded, then re-inspected.

Whenever a mast is to be inspected, drilling tools such as hooks, elevators, links, tongs, subs and related equipment should be cleaned and laid out beside the rig for inspection. The per-unit cost thus is reduced by having them all done at the same time.

The average cost of a thorough magnetic particle inspection, not including the cleaning or sand blasting that is done by the operator, is about $250. Such a typical job also would include inspection of the various tools listed above. The moderate costs involved become insignificant when compared to losses that could be sustained by a pulled-in mast or a fishing job. A typical inspection job of, say, a 90-foot mast, including the sheaves, requires about 10 hours. The service company can use its own portable source of power or, if necessary, 220 or 440-volt lease power; the voltage being stepped down to the required six to eight volts.

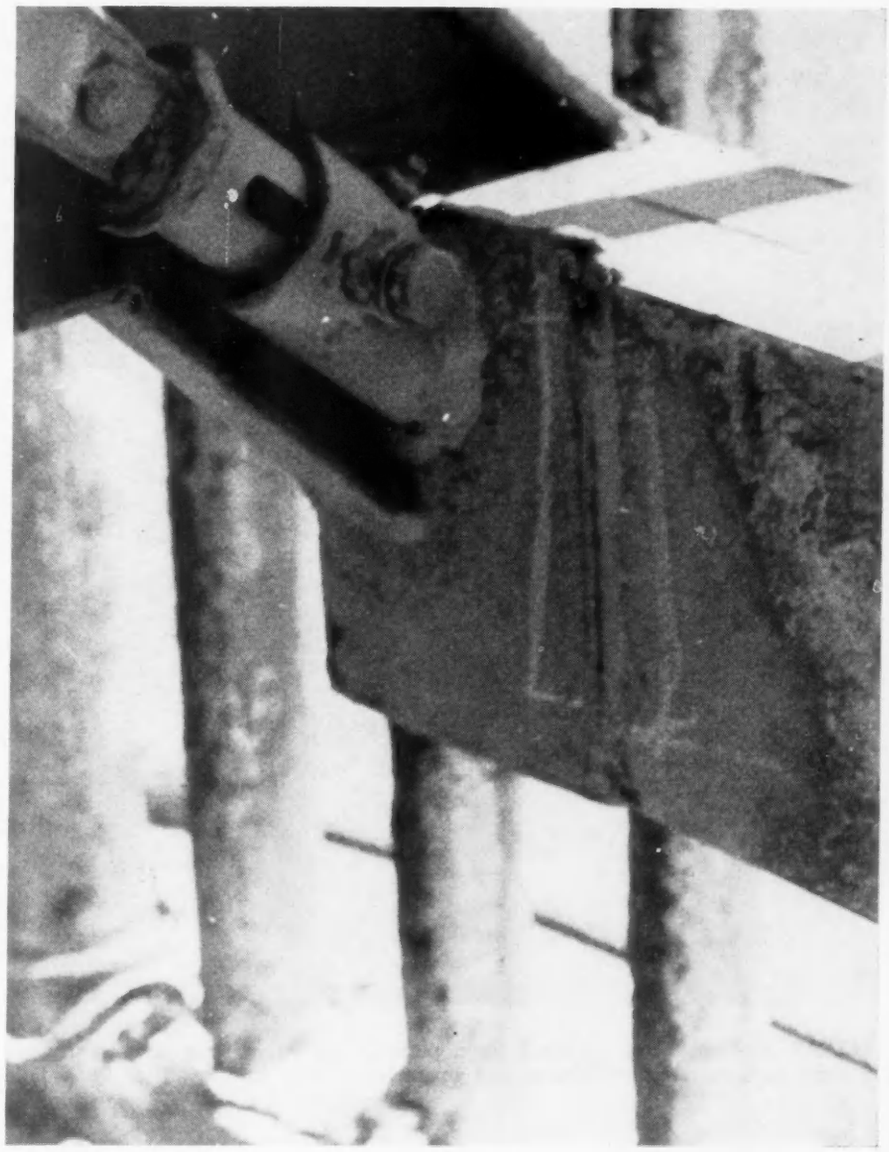


FIGURE 2—Indication of a flaw in the center of a weld (inside chalked area) was revealed during a scheduled inspection of this mast. Gouging or grinding out of the faulty weld and re-welding will prevent a future breakdown in the field.

Inspect every two years. Masts should be given a thorough inspection every year to two years. In some cases operators inspect a mast after a particularly rough drilling job, regardless of when it was last inspected, just to assure themselves that potential failures have not developed during the job just completed. Excessive vibrations sustained during hard drilling, accidentally running into the crown, or perhaps a harder-than-usual shock sustained in lowering the mast, are among the conditions that might make it wise to inspect the equipment upon completion of a job.

Subs and tool joints, inspected by making a 3-to 4-turn coil of the cable and placing it over the threaded area, often are found to have cracks in the root of the last engaged thread.

Magnetic particle inspection has proven successful on several drilling masts and equipment as shown by the results discussed here. A routine test of welds and guy line sockets was made on a drilling mast and 286 welds had indications of fatigue cracks. In addition, one of the sockets had three fatigue cracks ranging in length from one quarter to 1¼ inches. The welds were repaired and it was recommend-

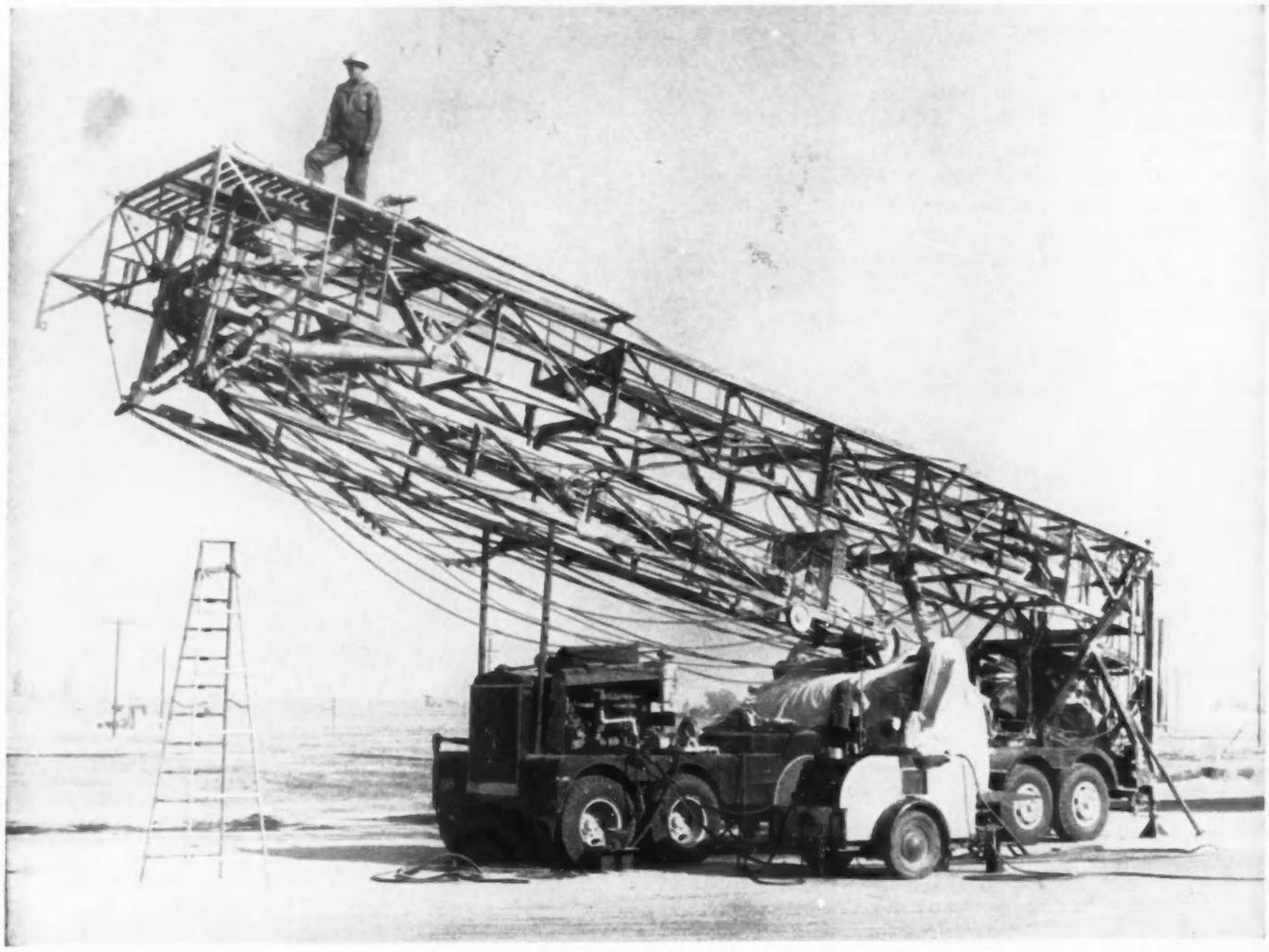


FIGURE 3—Mast being prepared for a periodic inspection. In right foreground is trailer-mounted magnetic particle inspection equipment. It is equipped to be operated with either 220 or 440-volt lease current.

ed that the faulty socket be taken out of service.

Another drilling mast, brought in for routine inspection, was revealed to have 29 welds that showed fatigue cracks ranging in length from one-half to 3 inches. Still another mast, on being inspected, was found to have between 140 and 150 cracks ranging in length up to 4 inches. The runaround platform on still another rig was found to have six indications of fatigue cracks, in addition to some 66 cracks in various parts of the rig structure.

Inspection of pulling unit masts has revealed equally serious defects in the structures. Although such masts may not receive as severe a service, day in and day out, as drilling masts, occasional difficult pulling jobs, workovers and more frequent raising and lowering of the masts nevertheless do make it necessary to periodically inspect them with the magnetic particle method. The following typical pulling mast case histories illustrate the point rather emphatically.

Recently a pulling mast was inspected and revealed two fatigue cracks ranging from one to 1⅜ inches long in the bottom half of the unit; two similar cracks in the welds of the crown block area and two more cracks in another part of the mast. In addition, five shrink cracks were found breaking out of the pin hole in one of the sheaves. Another mast, similarly inspected, was found to have nine indications of fatigue cracks in the lower section and three in the upper section of the structure, the cracks ranging in length from one to 2½ inches. In addition, each of two of the six hydraulic ram pistons had indications of two shrink cracks ranging in length up to one inch long. The raising assembly, three sheaves and the pin were found to be free of defects. On still another pulling mast, in addition to numerous fatigue and/or propagated shrink cracks, one of the push rods was found to have a crack approximately two inches long.

Production tools, likewise, should be checked periodically. One company, in testing some 50-odd pieces of equipment comprising tubing elevators, links, rod elevators, spiders, slips, guy line sockets and even conventional pipe wrenches, found fatigue cracks in approximately 25 percent of the items.

The preventive maintenance savings involved in such testing more than pay for the cost of inspection.

An increasing number of major and independent oil companies and drilling contractors are turning to the method in many producing areas of the United States. In some companies the practice has become a standard routine maintenance practice, to be scheduled at regular intervals in the same manner that engines, drawworks and other equipment such as compressors, are checked regularly.

—The End

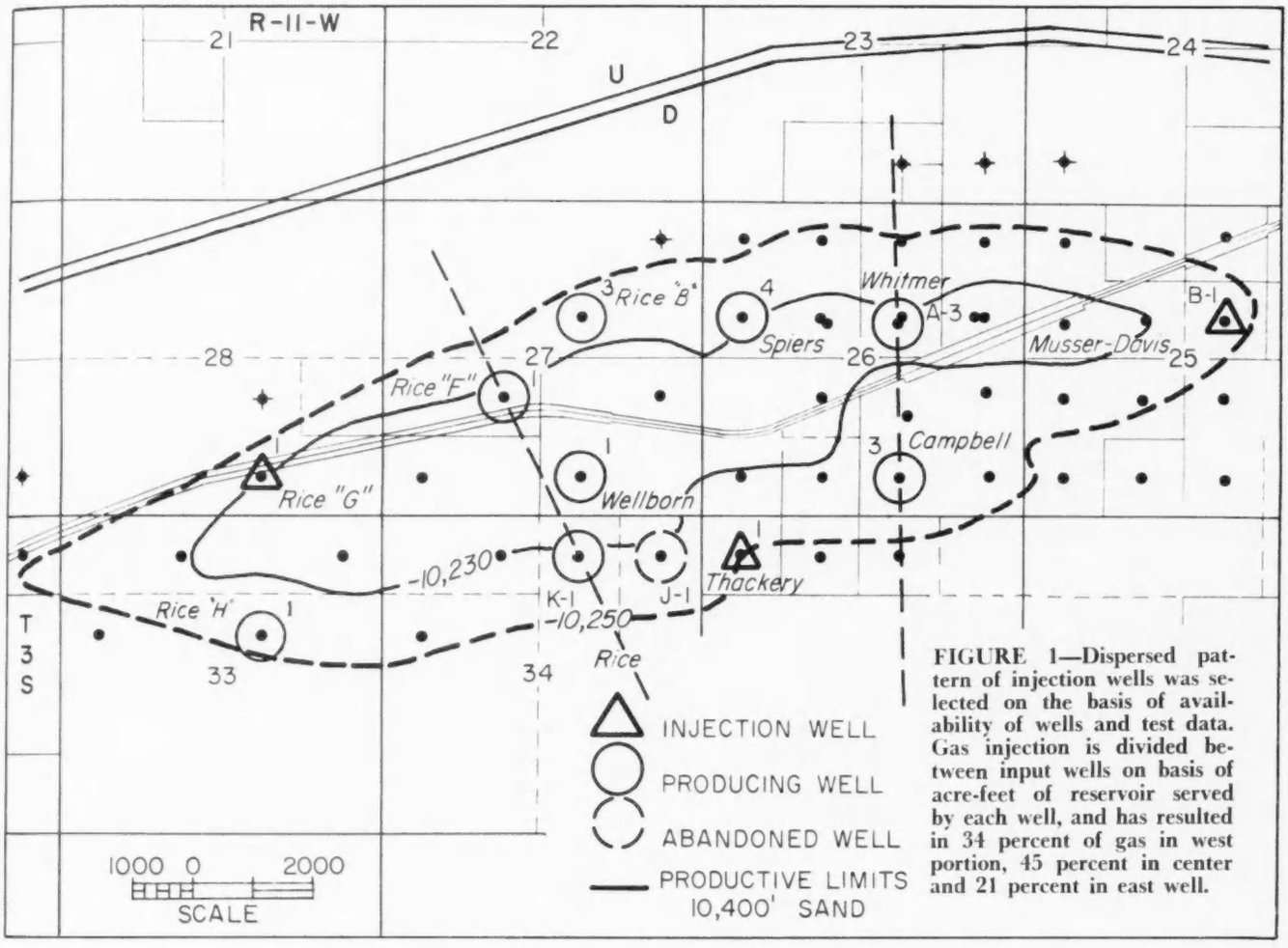


FIGURE 1—Dispersed pattern of injection wells was selected on the basis of availability of wells and test data. Gas injection is divided between input wells on basis of acre-feet of reservoir served by each well, and has resulted in 34 percent of gas in west portion, 45 percent in center and 21 percent in east well.

Case History . . .

Gas injection program pays off in South Louisiana

Atlantic's Neale field project has tripled production, increased ultimate recovery from 16 percent to 54 percent and cut per well operating costs 80 percent

By L. G. Shivers
Area Reservoir Engineer
The Atlantic Refining Company
Lafayette

THE ATLANTIC REFINING COMPANY's miscible phase displacement program in Neale field, Beauregard Parish, Louisiana, is expected to increase ultimate recovery to 54 percent of the oil originally in place. This is more than triple the 16 percent recovery estimated by primary means. In addition, the high pressure gas injection project has resulted in a threefold production increase; eliminated calcium carbonate deposition in the well-bore with a resultant 80 percent decrease in operating costs per well and increased plant product recovery by 250,000 barrels over that predicted under primary operations.

Injection into the 10,400 foot sand, which originally contained an estimated 3.7 million stock tank barrels of oil began in January 1956. At that time 290,000 barrels of oil had been recovered by primary production. Estimated ultimate recovery by primary was 600,000 barrels or 16 percent of original in-place oil. The balance of the primary reserve now has been recovered and the project is well into the secondary phase.

Geology. The Neale field structure is an east-west trending anticline on the downthrown side of a down-to-the-south regional fault (Figure 1). Another fault on the south flank parallels the regional fault. Although it is beyond the productive limits of the field, it may affect water movement from the south.

Dip rates within the productive limits are approximately 20 feet/1,000 feet or 1°. An oil-water contact at 10,250-feet subsea in the 10,400-foot sand limits production in all directions with a maximum 30-foot oil column. Productive area is about 2,000 acres with an average eight feet of net sand.

There are 11 producing Wilcox sands in the field from 8,300 feet-11,600 feet. The first Wilcox Sand at 8,300 feet is the only one with a strong water drive and it has had by far the best primary history. Other producing sands are all below 10,000 feet and are Middle Wilcox. The 10,400-foot sand is the third productive sand of the Middle Wilcox Series and may be considered typical. It is a tight, shaley, fine-to-medium grain sandstone, having a low permeability, high irreducible water saturation and contains a highly volatile oil.

Development. The discovery well for the field was Atlantic's Whitmer 1, completed in March 1940. Development continued into 1945, with generally 40-acre spacing in the east half of the field and 80-acre spacing in the west. Until the field was unitized, all wells were either singly completed or conventionally dually completed in the various Middle Wilcox Sands.

Completion practices included setting 2,500 feet of 10¾ inch-surface casing, drilling through the Frazar Sand at 11,600 feet and setting 5½ inch-production pipe. The primary cement job failed on many wells and it was often necessary to squeeze cement and reperforate in order to obtain waterfree production.

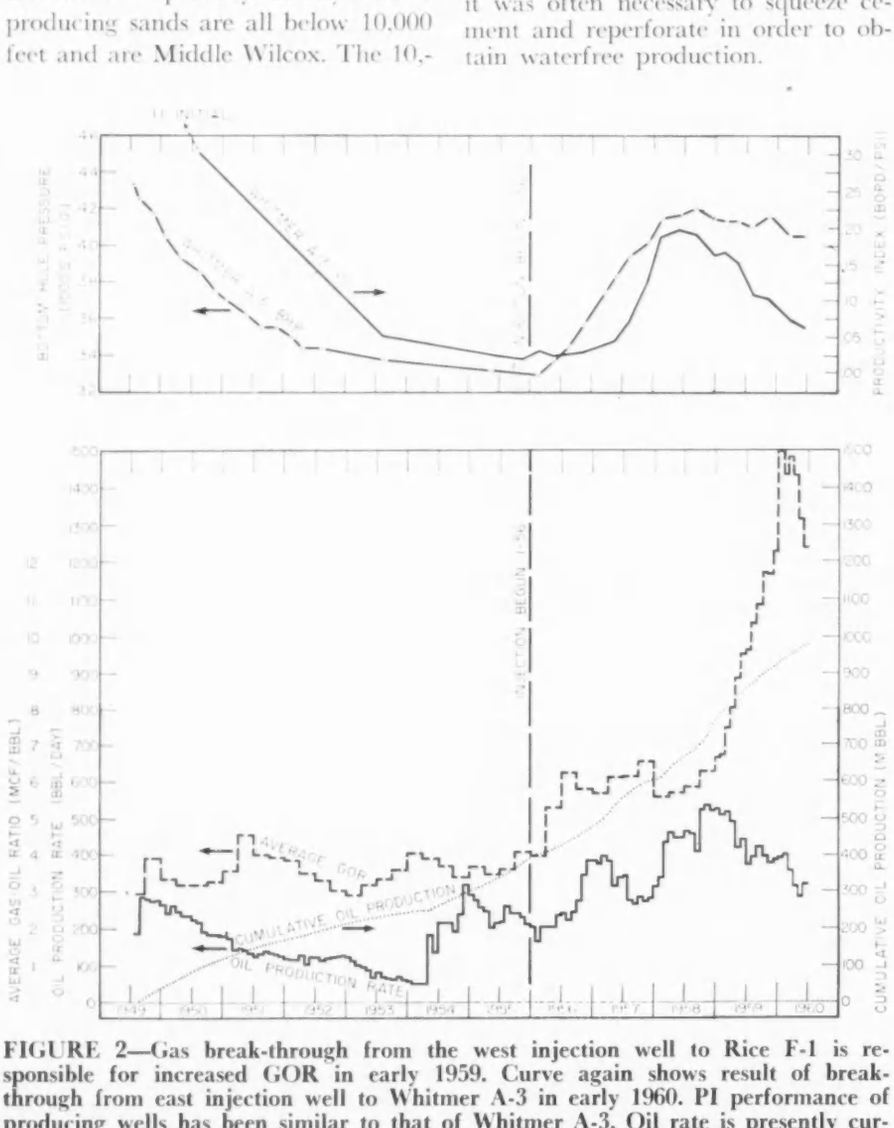


FIGURE 2—Gas break-through from the west injection well to Rice F-1 is responsible for increased GOR in early 1959. Curve again shows result of break-through from east injection well to Whitmer A-3 in early 1960. PI performance of producing wells has been similar to that of Whitmer A-3. Oil rate is presently curtailed to reduce reservoir voidage and curve does not represent maximum productivity of the reservoir.

Unitization. Production history of the Neale field by 1953 indicated that primary recovery on the average from eight Middle Wilcox oil sands would be less than 20 percent of the oil in place. Effective June 3, 1953, the Conservation Commission approved plans for operation on a voluntary field-wide unit.

The 10,400-foot high pressure gas injection program was one of three proposed projects to improve field recovery. This project was designed as a miscible displacement program with the average reservoir pressure to be above 4,000 psi. Laboratory tests indicated this pressure would result in a miscible phase displacement of the reservoir oil by residue gas from the Neale gasoline plant. A dispersed pattern of injection wells was selected and potentiometric model studies made to determine the most efficient pattern. The pattern shown in Figure 1 was selected with consideration given to the availability of wells and the test data from additional completions made in the 10,400-foot sand.

Performance before injection. In July and August 1949, the Whitmer A-3 and Rice J-1 were recompleted in the 10,400-foot sand. Production reached a peak of 283 bopd and then declined almost directly with reservoir pressure as shown in Figure 2. The Rice J-1 had produced 40,000 barrels of oil and 11,500 barrels of salt water when it reached an economic limit and was recompleted in another sand in May 1953. The production rate from the reservoir reached a minimum of 50 bopd early in 1954, just prior to completion of several additional wells in the sand.

Production and pressure history in other zones indicated permeability barriers within the field and the same possibility had to be investigated in the 10,400-foot reservoir. Five wells were completed in the 10,400-foot sand during 1954. Extensive production and BHP testing proved continuity of permeability throughout the reservoir.

The three injection wells then were completed in the 10,400-foot sand at structural positions near the original water-oil contact. The west injection well was put on production in July 1955, and was averaging 32 bopd with 65 percent SW when injection was begun. The other two injection wells produced 100 percent SW upon completion in June 1955. The oil rate

reached a peak of 320 bopd in December 1954, for an average of 53 bopd with 37 percent SW for each of the six wells on production. The reservoir production had declined to 200 bopd by January 1956, when injection was started.

The primary production mechanism was a partial water drive, with material balance calculations indicating a water influx of 690,000 barrels prior to January 1956. Cumulative production at the start of injection was 390,000 barrels of oil, 1,367 MMcf gas and 130,000 barrels of water. This production equaled about 1,400,000-reservoir barrels and had dropped the pressure in the central portion of the field from the original 4,340 psi to 3,300 psi. Average reservoir pressure in November 1955 was calculated as 3,550 psi.

Gas injection. In January 1956, injection was begun into three wells, one on each end of the field and one in the center as shown in Figure 1. An average of 3 MMcfd was injected into the reservoir during the first year. In January 1957, the volume was increased to slightly over 4 MMcfd, and, in September 1959, was increased to about 6.5 MMcfd. The injected gas volume has been divided between wells on the basis of acre-feet of reservoir served by the well. This division of area served by each well is shown by the dashed lines in Figure 1 and results in 34 percent of the gas to the west, 45 percent to the center and 21 percent to the east injection well.

No difficulty has been experienced in maintaining the desired volume of gas injected into each well. The surface wellhead pressures average about 3,900 psi, resulting in an average BH injection pressure of 4,900 psi. Quarterly, PI and 72-hour build-up pressure tests have been run on the injection and production wells.

Average reservoir pressure versus cumulative net injection is plotted in Figure 3. The average pressures were determined by extrapolating build-up pressures, using the Miller, Dyes, Hutchinson Method.[6] Although reservoir conditions do not fully satisfy all the basic assumptions used in developing this method, results obtained are considered satisfactory. This was confirmed by pressures measured on the Welborn 1 while it was shut-in for 18 months. Calculated build-up pressures of the producing wells have approximated the measured pressure on the Welborn. The 72-hour draw-down pressure of the injection wells was used and the average reservoir pressures calculated from isobaric maps.

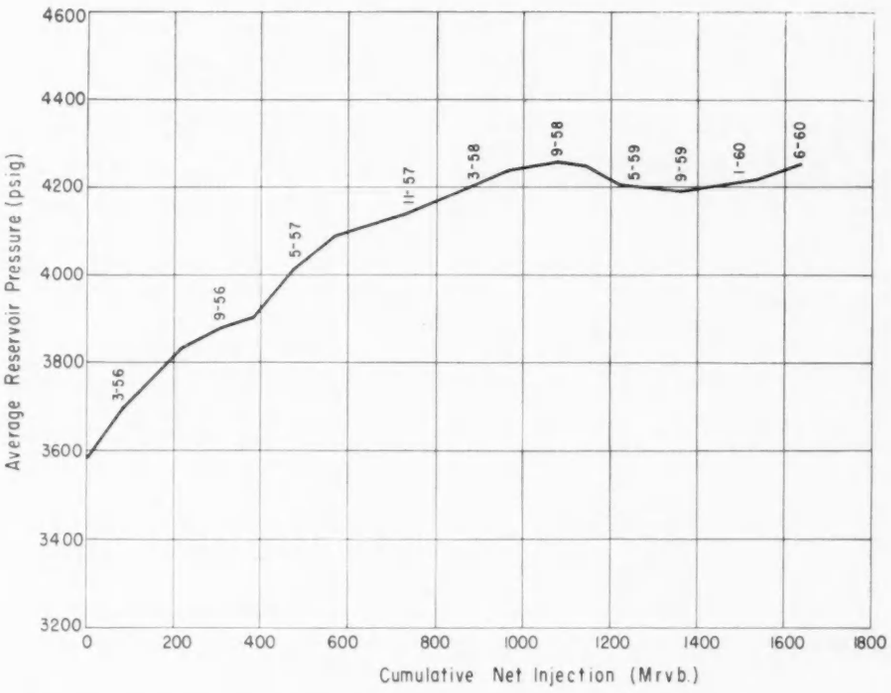


FIGURE 3—In a closed reservoir, plotted data should fall in a straight line. In this case, flattening of the curve is believed to be the result of repressuring the aquifer.

Reservoir barrels of production and injection was calculated at average reservoir pressure to arrive at the net injection shown in Figure 3. In a closed reservoir, the data shown in Figure 3 should result in essentially a straight line. Flattening of the curve as the reservoir pressure increased is believed to be the result of repressuring the aquifer.

With the start of injection, reservoir voidage was restricted in order to reach miscibility pressure as soon as possible. The desired minimum reservoir pressure of 4,000 psi was reached in May 1957, with a cumulative net gas injection of about 475,000-reservoir barrels. Production data indicated that oil was being produced as a bank from each end of the field. Considering the lower BHP and high GOR's in the center portion of the field, it was believed that free gas was flowing from injection to producing wells. Also, it was possible that an oil bank had not formed in this portion of the reservoir.

Reservoir pressure in the center section was about 300 psi below average, and it was decided to continue restriction of production to increase the reservoir pressure in the center section to the point of miscibility. By September 1958, an average reservoir pressure of 4,250 psi was reached with a cumulative net injection of about 1,000,000-reservoir barrels. In view of the pressure loss to the aquifer, it was then decided to balance production with injection.

Gas broke through from the west injection well to the Rice F-1 in January 1959, with 1,760,000-reservoir barrels of gas injected. This was a little earlier than expected from calculations based on the estimated sweep efficiency and allowing for loss to the aquifer. The resulting GOR increase may be noted in Figure 2 early in 1959. Approximately 1,200,000-reservoir barrels of gas had been injected into the east injection well when gas broke through to the Whitmer A-3 about January 1, 1960. Again, the GOR curve for the reservoir shows a noticeable change.

Performance after injection. The production history of wells producing from the 10,400-foot sand since the start of gas injection compared to production prior to injection emphasizes advantages of the program. Best results have been in the performance of Rice K-1, Rice F-1, and Campbell 3 wells.

Upon initial test in May 1954, the Rice F-1 flowed 104 bopd with 8 percent salt water from the 10,400-foot

sand. By January 1956, it had declined to 24 bopd with 50 percent salt water. In October 1956, the oil bank from the west injection well broke through to the well, and in a period of three months, production increased from 22 bopd on gas lift to 167 bopd flowing. Water production from this well has decreased from 100 to 25 bpd. GOR increased from 8,500/1 to over 20,000/1 in about six months following gas breakthrough early in 1959.

The Rice K-1 was recompleted in the 10,400-foot zone in May 1954 for an initial test of 129 bopd with no salt water. Oil rate had declined to 8 bopd with 70 percent salt water by April 1955, and the well was shut-in. After injection began, the well was opened and produced 100 percent salt water at a rate of 75 bpd until September 1957, when it again started producing oil. Oil gradually increased, and in December 1958, averaged 134 bopd, GOR 4,300/1, with 25 percent salt water. This well is still producing over 100 bopd with a cumulative oil production since start of injection in excess of 90,000 barrels.

Campbell 3 was recompleted in the 10,400-foot sand in July 1954, with an average production of 9 bopd with 95 percent salt water and was TA in July 1955. In June 1956, it was returned to production and was averaging 3 bopd with 98 percent salt water in July 1957 when it was again shut-in. BHP tests indicated communication with a low pressure reservoir since BHP would only build up to about 3,400 psi. In February 1958, the 10,400-foot sand was isolated by resetting the packer and the well flowed 95 bopd, GOR 3,900/1, with 25 percent salt water. The shut-in BHP then reached the normal 4,100 psi in 72 hours. The water-oil front had apparently moved past this well while it was shut-in, confirming the material balance calculations which indicated that the oil-water contact was receding. Campbell 3 produced 28,000 barrels of oil at an average GOR of 6,600/1 prior to being shut-in in March 1959, because of excessive GOR.

The Rice B-3 and Rice H-1 were completed in the 10,400-foot reservoir in May and June 1960, respectively. These wells are low on structure, well removed from the injection wells and were completed in an effort to reduce the field GOR. Rice B-3 produced 100 percent SW for about three months at a rate of 250 bpd. It now is producing 5 bopd with 98 percent SW. Rice H-1 produced its first oil after about three weeks and is now producing 20 bopd with 90 percent SW.

The PI performance of the producing wells has been similar to that of the Whitmer A-3 as shown in Figure 2. The original PI of the A-3 well, measured at completion, was 1.1 bopd/psi draw-down. PI declined rapidly with decreasing pressure, increasing GOR and water percent, reaching a low of 0.02 just prior to start of injection. The PI reached a new peak of 0.2 in May 1958, with a BHP of 4,170 psi and a GOR of 3,100/1. The PI to oil has declined since the first of 1959, due to increasing GOR.

Effects of injection on the GOR's of Welborn 1 and Spiers 4 were noticed immediately. Ratios gradually increased from about 3,500/1 to over 10,000/1 in a period of 18 months. This increase and the continued high GOR's in the center portion of the field have been the most perplexing problems in the program.

There are a number of possible explanations for the high GOR's. One possibility is that an oil bank has not formed around the center injection well and that the gas flows through a continuous gas phase to the producing wells. Material balance calculations gave a free gas saturation in the center section of about 25 percent just prior to injection, which is more than ample for free gas flow. It was thought that, with increasing pressure, the oil would swell by taking gas into solution, to the point where an oil bank would form.

Liquid recovery from the 10,400-foot sand by the field gasoline plant has been considerably higher than predicted. This fact, along with the GOR performance, indicates the possibility of substantial liquid vaporization[7] due to the cycling of dry gas, particularly in the center portion of the field.

Another possibility is that the gas is moving to the producing wells through a small stringer of sand with miscible displacement of oil in the remainder. GOR's in several of the wells tend to increase with low oil rates and decrease with high oil rates. The GOR sensitivity to rate as well as the early free gas production could result from free gas flow through a sand stringer.

Experimental simultaneous injection of gas and water was begun in the center injection well in January 1960, to evaluate this possibility and to minimize its effects if it existed. Efforts to inject gas and water simultaneously were abandoned because of the reduction in injection rate at the pressure limit of the gas compressors. Alternate injection of gas and water has continued with no conclusive results to date. As expected, the injection capacity of the well has been reduced due to the increased water saturation in the vicinity of the wellbore.

The reduction in oil rates shown in Figure 2 were made to reduce reservoir voidage as the GOR's increased and do not represent a maximum productivity of the reservoir.

About the Author

L. G. Shivers received a B.S. degree in civil engineering from The University of Texas in 1949. He worked two years in oil field construction prior to returning to school at the University of Houston where he received an M.S. degree in petroleum engineering in 1953. He joined The Atlantic Refining Co. as a production engineer in Duncan, Okla., in February 1953, and was transferred to the Reservoir Engineering Department in Tulsa, Okla., in 1954. For the past four years he has been located in Atlantic's regional office in Lafayette, La.

LITERATURE CITED

[1] Whorton, L. P. and Kieschnick, W. F., Jr.: "A Preliminary Report on Oil Recovery by High-Pressure Gas Injection," *Oil and Gas Journal* (April 6, 1950), 78.

[2] Griffith, B. L. and Hollrah, V. M.: "New High Pressure Gas-Injection Method," *Oil and Gas Journal* (April 6, 1953), 84.

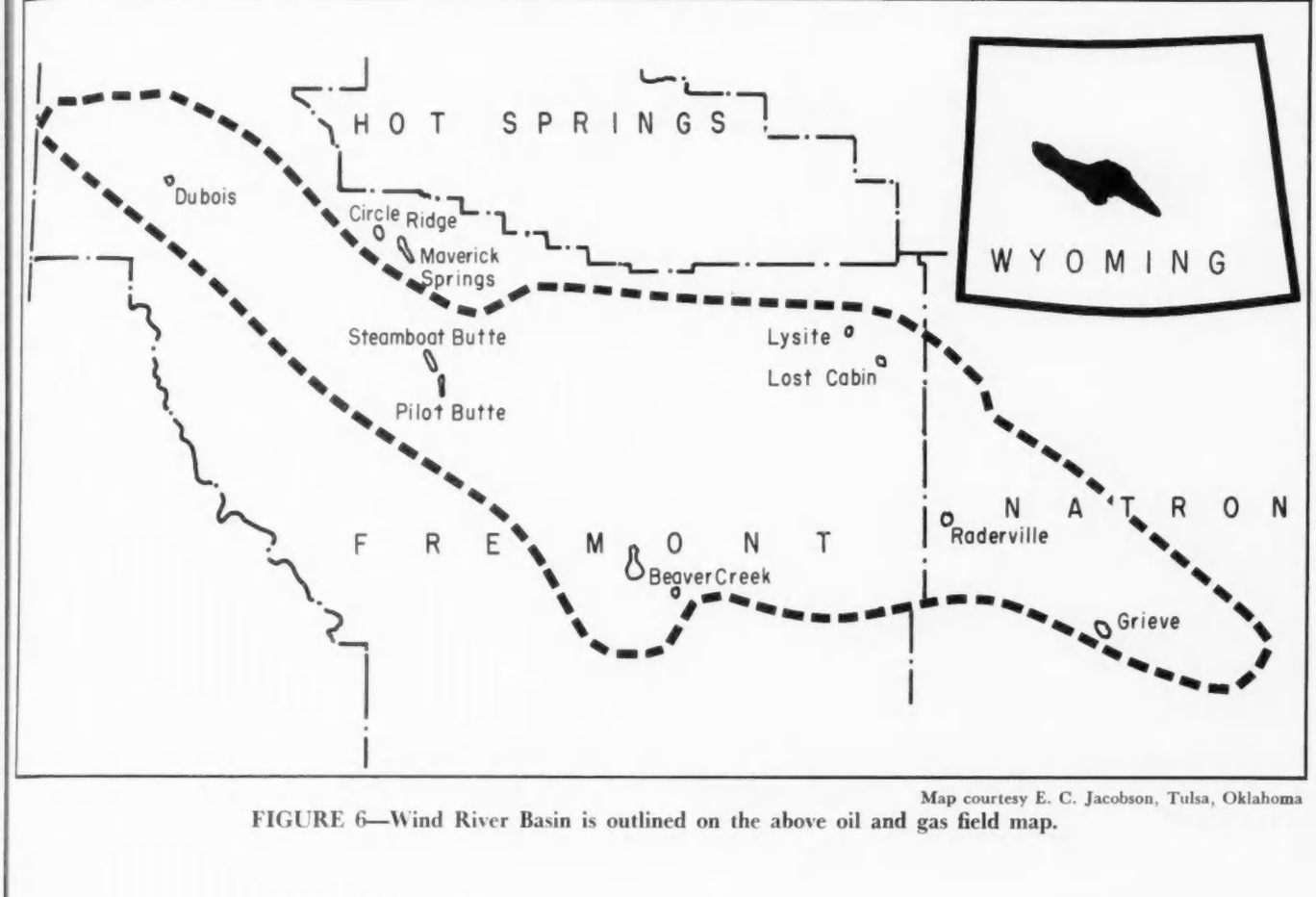
[3] Slobod, R. L. and Koch, H. A.: "High Pressure Gas Injection," *Oil and Gas Journal* (April 6, 1953), 84.

[4] Brownscombe, E. R.: "Atlantic High-Pressure Gas Process Being Used in West Texas' Block 31 Field," *Oil and Gas Journal* (June 14, 1954).

[5] Barney, C. L.: "Petroleum Vaporization Recovery by High Pressure Gas Injection," Fall Meeting SPE of AIME, October 6-9, 1957.

[6] Miller, C. C., Dyes, A. B., and Hutchinson, C. A., Jr.: "The Estimation of Permeability and Reservoir Pressure from Bottom Hole Pressure Buildup Characteristics," *Transactions AIME* (1950), Vol. 189, p. 91.

[7] Jacoby, R. H., Berry, V. J., Jr.: "A Method for Predicting Pressure Maintenance Performance for Reservoirs Producing Volatile Crude Oil," *Transactions AIME* (1958), Vol. 213, p. 59.



Map courtesy E. C. Jacobson, Tulsa, Oklahoma

FIGURE 6—Wind River Basin is outlined on the above oil and gas field map.

PART 2 ROCKY MOUNTAIN FOUR-BASIN REPORT

WIND RIVER BASIN . . .

. . . during 1960, Beaver Creek has become Wyoming's second largest oil field

Beaver Creek field—since Pan American Petroleum Corporation initiated water flood programs in the Cretaceous Second Cody sandstone and the Mississippian Madison dolomite, Beaver Creek has emerged as one of Wyoming's most significant oil producing fields, and this year exceeded Cottonwood Creek, largest producing oil field in the Big Horn Basin.

Beaver Creek field is south of Riverton on a federal unit operated by Pan American for itself and two other firms. Its six productive hydrocarbon zones include three oil reservoirs (Second Cody sandstone, Tensleep sandstone and Madison dolomite) and three gas reservoirs (Frontier, Muddy and Lakota sandstones, all of Cretaceous age).

Pan American owns about 85 percent interest in the gas units, 100 percent of the oil units and the firm operates a gas processing plant at the field.

During 1959, hydrocarbon production from Beaver Creek was about 6,250 barrels of oil and natural gas liquids per day and about 30 MMcf of natural gas per day. Hydrocarbon production has increased substantially this year.

Circle Ridge field—is between the Owl Creek and Wind River ranges in the northwestern part of the Wind River Basin in Fremont County, Wyoming.

Structure is a tightly-folded, partly overturned anticline asymmetric to the southwest. Production is found in the Mississippian Madison limestone, Pennsylvanian Tensleep sandstone, and Permain Phosphoria dolomite. High initial oil production of black 23° API gravity crude are obtained from these horizons at drilling depths of less than 2,000 feet.

The most striking structural feature of the anticline is an east-dipping thrust fault which cuts the east limb.

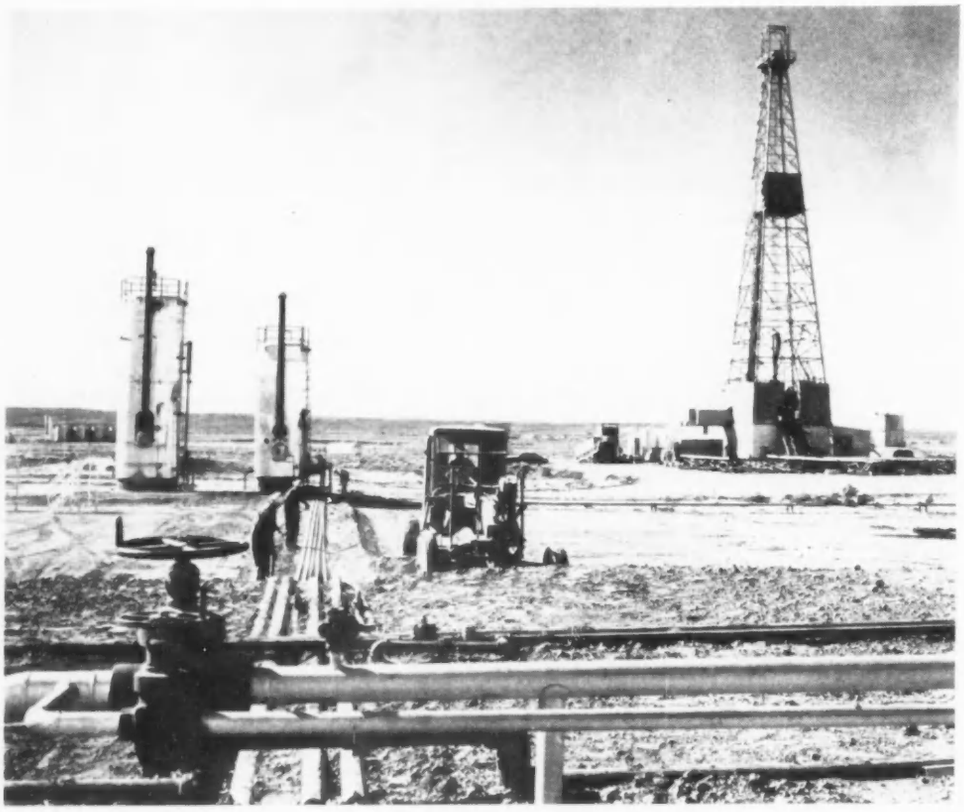


FIGURE 7—Beaver Creek field located southwest of Riverton in Fremont County, is one of the principal oil producing fields in Wyoming. This view shows Pan American field crews connecting up a new completion. Drilling well at right was completed in the Mississippian Madison formation, deepest of the six producing hydrocarbon reservoirs.

Faulting results in repetition of the Tensleep and Phosphoria oil pays on the north end of the structure.

Seventy Madison, Tensleep and Phosphoria wells are producing from the overthrust block. About 16 oil wells have been completed in the Tensleep and Phosphoria below the thrust plane. Some wells are spudded in the Phosphoria which is brought to the surface by the overthrust east limb.

The reservoir above the fault has dip closure of between 20° and 40° on the northeast, east and southeast flanks; the fault provides the west closure. Known productive closure on the Phosphoria is 1,400 feet. Reservoir mechanism is a water drive, but reservoir pressures are low and wells must be pumped.

Circle Ridge anticline is well named. A mile-long northwest-trending topographic depression, paralleling the axis, has been cut into the red shales and siltstones of the Triassic Chugwater formation. On the gentle east and northeast sides of the fold, concentric hog-backs of bright-colored Triassic, Jurassic and Cretaceous rocks rings the structure. A small-rounded hill of Phosphoria dolomite rests in fault contact upon the upper beds of the Chugwater on the steeply dipping to overturned west flank.

Southeast Sheldon prospect. During November, 1960, a new Upper Cretaceous oil and gas field was indicated on drillstem tests conducted at an exploratory test drilled 1¾ths miles southeast of the Sheldon townsite in Fremont County, Wyoming in the Wind River basin.

Plymouth Oil Company's Tribal 1, C SE SW/4 Sec. 23-5N-2W, flowed gas that burned with a 2-foot flare after a drill-stem test conducted at 4,740 feet with packer set at 4,664 feet. Oil-cut mud flowed after 65 minutes. On another drillstem test conducted at 4,672 feet with packer set at 4,662 feet, the well flowed gas in 40 minutes. On last field report, it was drilling ahead on a 7,500-foot depth contract to the Pennsylvanian Tensleep sandstone major objective.

The well is situated on a farm-out from Kerr-McGee Oil Industries, Inc., Phillips Petroleum Company, and Carter division, Humble Oil & Refining Company.

GEOLOGICAL SUMMARY

Wind River Basin in western Wyoming is bounded on the north by the Owl Creek-Bridger Uplift and by the southern portion of the Absaroka Range; on the east by a line of folding and faulting between the Laramie and Big Horn Mountains which separates the Wind River Basin from the Powder River Basin; on the south by the Sweetwater Uplift and on the southwest and west by the Wind River Uplift.

The major synclinal axis of the Wind River Basin lies near the northern limits of this major asymmetrical structural syncline. The central portion of this basin is filled with Tertiary Eocene sediments which do not reflect generally the attitudes of the disturbed pre-Tertiary rocks.

Paleozoic. The section in the Wind River Basin includes about 3,500 feet of nearly conformable marine Paleozoic rocks including shales, dolomites, limestones and sandstones.

Mesozoic. Rocks of Mesozoic age include about 9,500 feet of predominantly marine fine-grained to medium-grained clastic sediments, mostly sandstones and shales, with only minor carbonate thicknesses.

At the end of Mesozoic time, the Wyoming shelf rose above sea level and although there was a continuation of sedimentary deposition, its character changed radically from a marine environment to a continental environment.

Tertiary. About 3,500 feet of land-deposited clastics are represented in the sedimentary section of Tertiary age; thickness varies less than 1,000 feet to a maximum of 4,000 feet. Lithology is generally eroded frag-

ments of Paleozoic and Mesozoic rocks which were redeposited in reverse order from erosion of the rising ranges. The younger Tertiary sediments contain increasing percentages of volcanics.

During the Laramide orogeny, deep-seated compressional forces overthrusting westward and southward constructed a rough parallelogram of mountian ranges circumscribing the Wind River Basin including the Owl Creek Mountains to the north, the Wind River Mountains to the west (over 14,000 feet above sea level), the relatively low Powder River lineament to the east and the Granite Range to the south.

Middle and late Tertiary upwarping and normal or tension faulting followed the compressive orogeny and the entire region was then subjected to erosion.

Oil and gas traps. Possible oil and gas traps in the Lander region have been cited as follows:

1. Stratigraphic traps in pre-Tertiary rocks situated along the southwest flank of the Wind River Basin syncline.
2. Anticlines concealed by Tertiary rocks and alluvial deposits.
3. Fault closures on plunging noses.
4. Upturned strata lying beneath the thrust or reverse faults.
5. Small closures on the ends of well-known anticlines which have been caused by sinuous axes and the offset of axes by faults.
6. Subsurface anticlines that do not correspond with the surface anticlines because thrust faults cutting Mesozoic rocks have moved the surface structures west of the roots that lie at depth in competent Paleozoic rocks.

BIG HORN BASIN . . .

. . . has two of Wyoming's most productive oil fields plus excellent oil and gas potential

Elk Basin field—Wyoming's largest producing oil field, is yielding an average of 60,000 barrels per day. It ranks among the top 10 U.S. producers and is one of America's most outstanding oil operations, particularly in its conservation aspects.

There are three oil-producing horizons, of which the Embar-Tensleep is the most prolific reservoir. Pan American Petroleum Corporation operates the field and a gasoline plant. The plant processes sour gas, extracting elemental sulfur and liquid petroleum products. A special boiler in the plant burns sweetened casinghead gas to generate flue gases which are injected into the Embar-Tensleep as part of a pressure-maintenance program.

The field discovery formation, the Frontier, is also under pressure-maintenance, one of the oldest secondary recovery programs in Wyoming. The Madison formation is the deepest producing oil reservoir in the field.

All production except the Frontier is handled through 12 positive displacement meter type Lease Automatic Custody Transfer Units. The Elk Basin LACT installation is one of the largest of its type in the world today, handling about 60,000 barrels of oil daily.

Cottonwood Creek field—is located near Worland, Wyoming. A federal unit of some 22,000 acres, Cottonwood Creek is the first major Wyoming oil field, and one of the first U.S. fields to be drilled on 160-acre well spacing.

By mid-1958, the field had become Wyoming's second largest producing field in daily output. In 1959, production averaged about 7,400 barrels of oil and natural gas liquids a day. However, in 1960, Beaver Creek field production is exceeding that of Cottonwood Creek.

The producing reservoir is the Phosphoria dolomite of Permian age. This reservoir has been under partial pressure-maintenance by gas-injection since June 1958. Gas is being injected into the formation at a wellhead pressure of 2,500 psig. Initial reservoir pressure was 3,900 psig for a depth of 7,270-9,665 feet at discovery in 1953. Three years after discovery, reservoir pressure had declined only 10 psi.

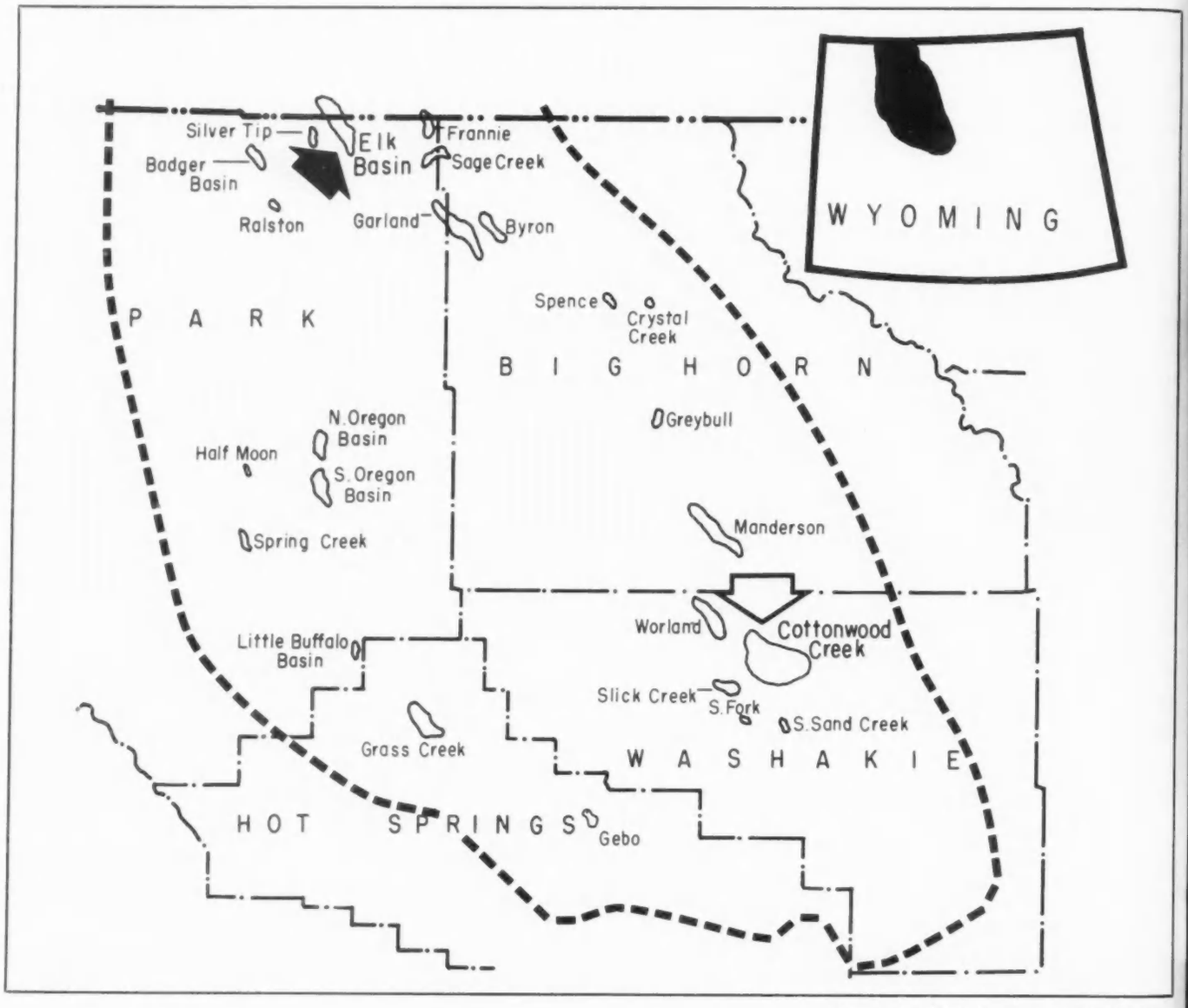
Grass Creek field—is situated along the crest of a major line of folding on the southwest rim of the Big Horn Basin in Hot Springs County, Wyoming. This is a typical Rocky Mountain field, a surface basin about seven miles long and three miles wide and surrounded by prominent escarpments or rim rocks.

Productive areas of the field are defined by a tilted water table on the flanks of the anticlinal structure with over 2,000 feet of closure.

The Frontier formation has produced some 33 million barrels of oil from a total of 335 wells since initial discovery in 1914. Secondary recovery by gas injection under unit operations has been carried out since March 1957. Current production is approximately 750 barrels of oil per day from 80 wells. A pilot water injection program will be initiated by 1961.

The Curtis formation has produced some 12.5 million barrels of oil from 164 wells. The Ohio Oil Company is now operating a unitized water flood in this formation. Water injections into eight wells on the flank of this reservoir has increased production from 2,200 barrels of oil per day to 3,300 barrels. An ultimate rate of 20,000 barrels of water injection per day is planned.

The Embar-Tensleep formation has produced 28½ million barrels of oil since 1922. Current production from 43 wells is 7,400 barrels per day.



Map courtesy E. C. Jacobson, Tulsa, Oklahoma

FIGURE 8—Big Horn Basin oil and gas field map shows by solid arrow the Elk Basin fields currently producing 60,000 barrels of oil per day—one of the 10 top U.S. oil fields. Hollow black arrow points to Cottonwood Creek oil field, third largest producing field in daily output in Wyoming.

Owing to a natural, active water drive, no secondary recovery is planned for this horizon.

The deepest production in the Grass Creek field is from the Darwin and Madison formations, which produce from 4,400 to 4,500 feet. Commercial production was discovered in these formations in 1958. Production is confined to seven wells on the crest of the structure where 800,000 barrels of oil have been produced to date. These formations, along with the Curtis and Frontier, are unitized and operated by The Ohio Oil Company.

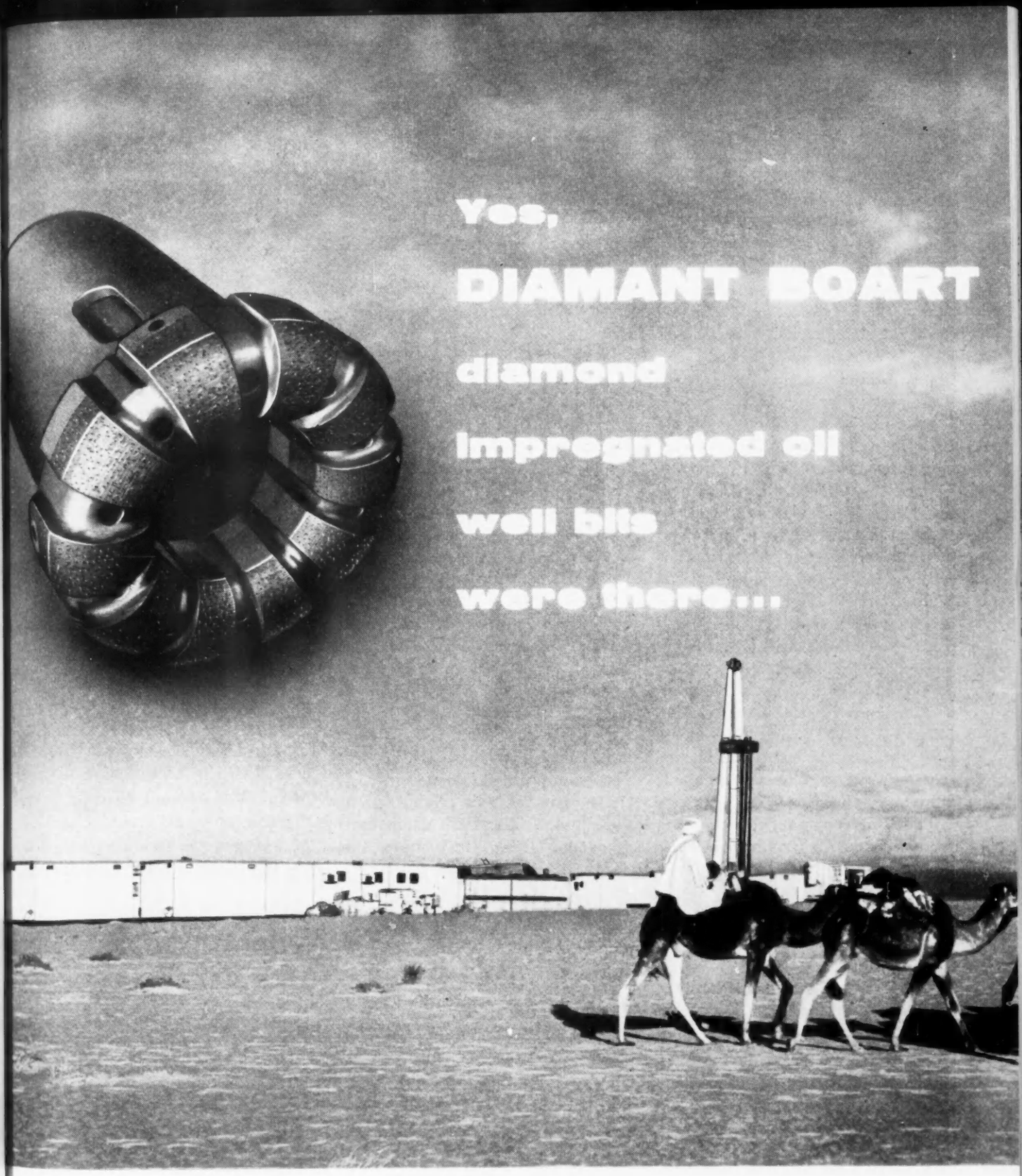
Byron field—located in Big Horn County, Wyoming, is a faulted anticline with the Cody shale and Mesaverde sandstone exposed on the surface.

At the present time, two gas wells and one oil well are producing from the Torchlight formation, 60 oil wells from the Phosphoria and Tensleep formations, and four oil wells from the Amsden formation.

The oil from Phosphoria-Tensleep, the major producing horizons (5,600 barrels per day) is a black oil with a gravity of 23° API. As the gas in solution is extremely low it is necessary to pump all producing wells. The reservoir is producing under an active water drive which should result in excellent recoveries from these formations.

Major operators in the Byron field are The Ohio Oil Company, Mule Creek Oil Company, Farmers Union Oil Company, and Taylor Oil Company.

Oregon Basin field—is a large topographic depression occupying the crest of a north-trending anticline lying on



low they will be available in your country very soon too...

DIAMANT BOART, S. A.
Diamond Impregnated Tools and Products
74, Avenue du Pont de Luttre, BRUSSELS 19, Belgium.
Phone : (02) 43.51.08
Telegr. : DIAMANTBOART-BRUXELLES
Telex : DIAMANBOART BRU 266

the west side of the Big Horn Basin in Park County, Wyoming. The field is in reality two fields which occupy two separate closed domes, commonly referred to as North Dome and South Dome.

All hydrocarbons below the top of the Chugwater formation were unitized in 1947 with The Ohio Oil Company acting as unit operator and Husky Oil Company, Trigood Oil Company and Texaco Inc., having major working interests.

Since the initial discovery in March 1927, some 76 million barrels of oil have been produced from 163 Embar-Tensleep wells drilled in the North and South Domes. One hundred twenty Embar-Tensleep wells are still producing in excess of 10,000 barrels per day. An original gas cap in the Embar lime has expanded until productive wells are now confined to a ring of wells in each dome which lies between the gas caps and the aquifer. This producing area has been stabilized in recent years by conservation programs which included gas injection and proration of production so that reservoir pressure has been stabilized.

The Tensleep reservoir is being produced under a combination water drive (natural) and gas expansion type mechanism. Water injection, now 10,000 barrels per day, will be increased during future productive life.

The Madison lime has produced 13 million barrels of oil from 43 wells drilled in both domes since 1943. Current production of 4,000 barrels per day is being maintained by using high volume pumping equipment. The fractured type reservoir, in conjunction with a very active aquifer, has forced the operator to handle large quantities of water produced with the oil. Down-hole centrifugal pumps have been used extensively in this connection. Currently, gas is being injected on the flank as another means of adding to ultimate recovery.

Garland field—located in Park and Big Horn counties, Wyoming, is an anticline along a line of folding that trends northwest and southeast in the northern part of the Big Horn Basin.

At the present time, two Embar and two Tensleep wells are capable of producing gas from the two gas caps. To obtain greater ultimate oil recovery, no gas has been produced from these wells since 1952. Cumulative production (since 1937) from Tensleep is 42 million barrels.

There are 26 oil wells producing 1,350 barrels of oil per day from the Embar formation. Of these, 21 are dually completed in the Embar and Tensleep formations. Cumulative production (since 1927) from the Embar is 1.1 million barrels. Approximately 17½ MMcf gas per day is being produced with the Embar and Tensleep oil.

As a result of a decline in reservoir pressure in the Tensleep formation on the northwest flank of the structure, a pressure maintenance program utilizing both gas and water was instituted in 1958. At the present time approximately 6,000 barrels of water and 300 Mcf of gas are being reinjected daily.

At the present time, 41 wells are producing 3,500 barrels of oil per day from the Madison formation. Cumulative production (since 1930) is 17 million barrels of oil.

In 1958, oil development in the Amsden formation was initiated. At the present time 10 wells are producing 450 barrels of oil per day. Cumulative production is 275,000 barrels.

Major operators in the Garland field are The Ohio Oil Company, Mobil Oil Company, Farmers Union Oil Company, Flank Oil Company, Mule Creek Oil Company and Ajax Oil Company. —The End

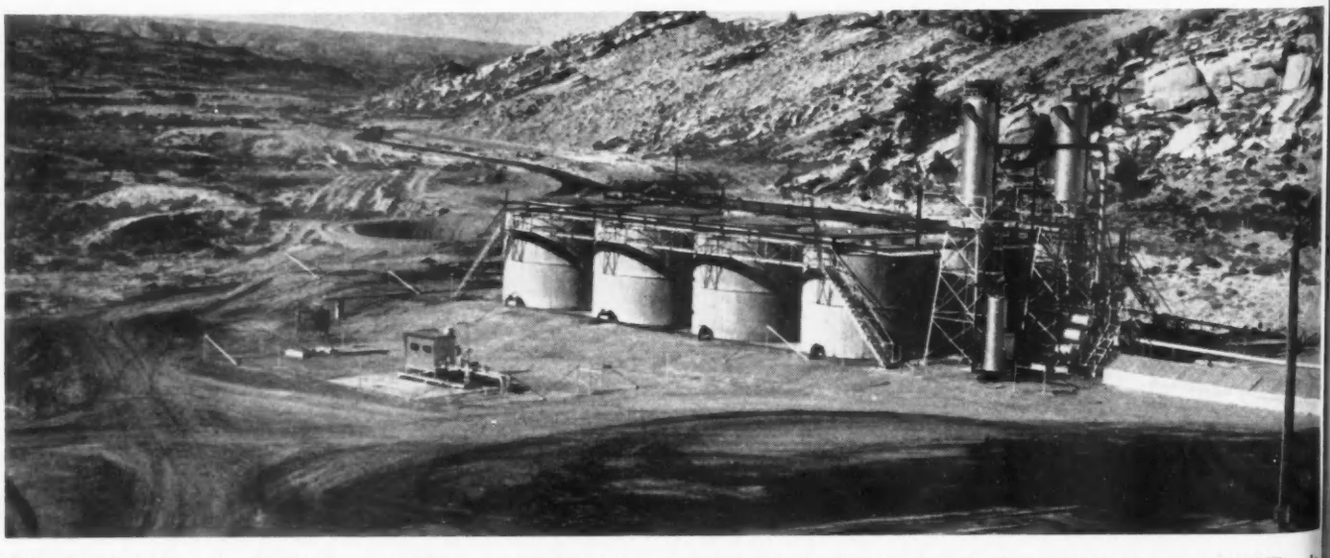
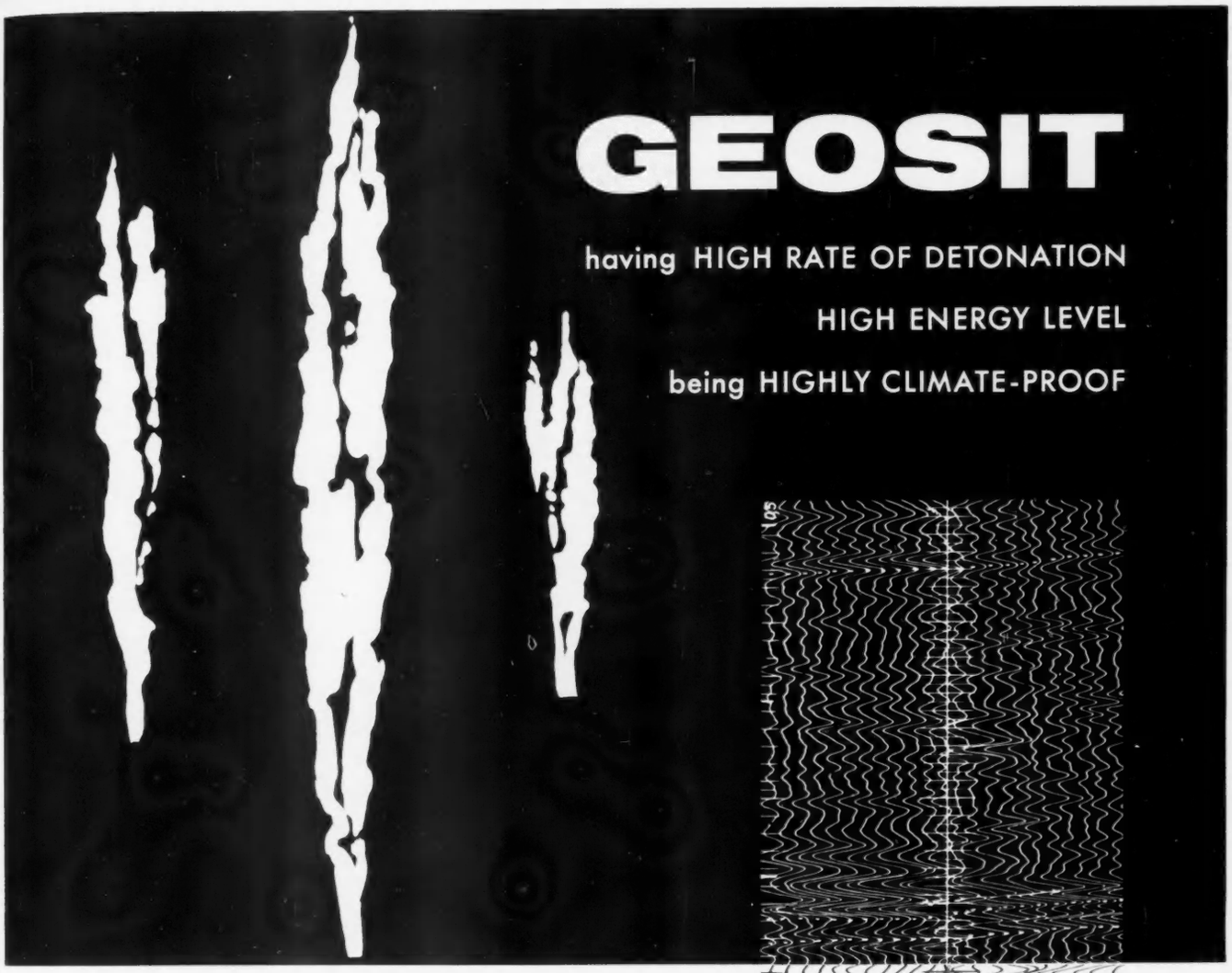


FIGURE 9—Elk Basin field lease automatic custody transfer unit near Cody, Wyoming represents one of largest of its type in the World, handling about 60,000 barrels of oil daily. In left center is the positive displacement meter type LACT unit; behind and to right is Tank Battery Number 4. LACT replaces all of old battery except oil and gas separators, and oil treaters.

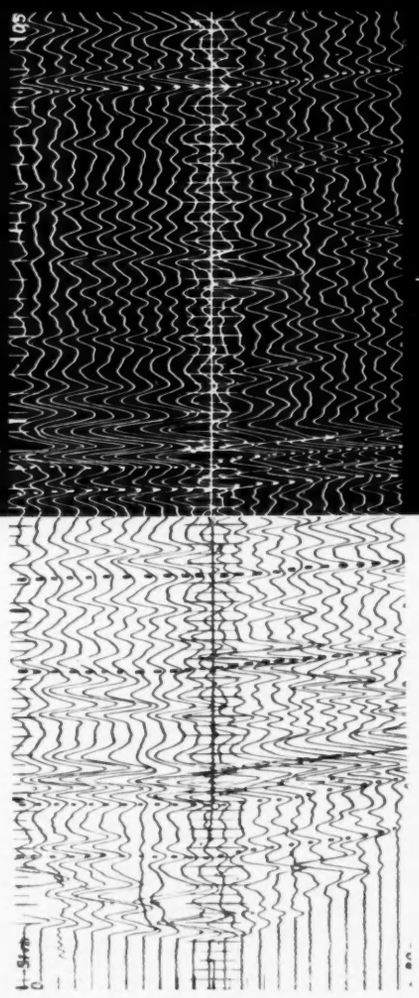


GEOSIT

having HIGH RATE OF DETONATION

HIGH ENERGY LEVEL

being HIGHLY CLIMATE-PROOF



W 101

WASAG supplies further different types of
SEISMIC EXPLOSIVES
powdery and gelatinous
suitable for all kinds of REFLECTION
and REFRACTION WORK
available in any desired cartridge type with
or without fast coupler

plus WASAG's blasting agent **WASAMON**

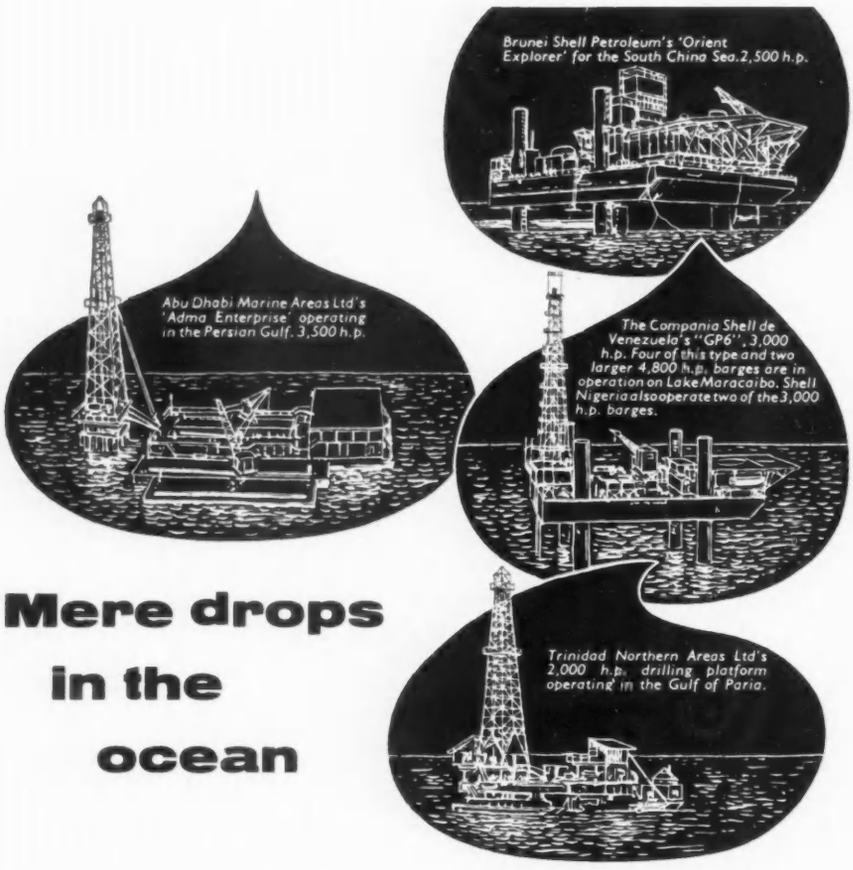
Long experience and continuous development
guarantee the quality of our products

Agencies in all Parts of the World.

For further information please contact

WASAG-CHEMIE AG

ROLANDSTRASSE 9 ESSEN/GERMANY

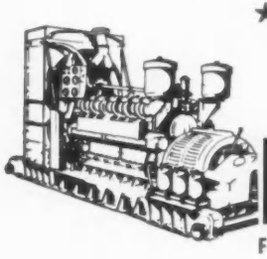

Brunei Shell Petroleum's 'Orient Explorer' for the South China Sea. 2,500 h.p.
Abu Dhabi Marine Areas Ltd's 'Adma Enterprise' operating in the Persian Gulf. 3,500 h.p.
The Compania Shell de Venezuela's "GP6", 3,000 h.p. Four of this type and two larger 4,800 h.p. barges are in operation on Lake Maracaibo. Shell Nigeria also operate two of the 3,000 h.p. barges.
Trinidad Northern Areas Ltd's 2,000 h.p. drilling platform operating in the Gulf of Paria.

Mere drops in the ocean

Specks on the horizon, small in comparison to the oceans surrounding them but powerful self-contained working units, these drilling platforms and barges are employed in round-the-clock exploration drilling from the Persian Gulf to the South China Sea . . . just a few of many offshore structures powered by dependable Paxman diesels.

Check these facts on Paxman diesels for your next offshore installation:

- ★ **Liquid-cooled engines 100—2,400 h.p.**
- ★ **Air-cooled engines up to 466 h.p.**
- ★ **Compact and lightweight.**
- ★ **Maximum interchangeability of engines and components for all services.**
- ★ **Mechanical or electric transmission for rig engines.**
- ★ **The only British field-proven quantity-built oilfield engines ashore or afloat.**



PAXMAN diesels

FOR ALL OILFIELD DUTIES AFLOAT AND ASHORE

6", 7" and 9¾" bore, ranging from 90 to 2,400 h.p.

DAVEY, PAXMAN & CO. LTD., COLCHESTER, ENGLAND *a member of the* RUSTON *Group.*

How to estimate

By Allen G. Leshikar
Consulting Petroleum Engineer
Refugio, Texas

THE TEXAS RAILROAD COMMISSION has ordered that producers of gas-condensate wells within the State report full well stream gas volumes rather than residue gas volumes as has been the practice in the past. Figure 1 can be used to quickly convert monthly condensate production to its equivalent gas volume and thereby obtain the necessary data for proper reporting of gas-condensate production.

Where lease separation facilities are utilized and only residue gas is metered, some means must be employed to convert the measured quantities of dry gas and stock tank condensate back to a full well stream volume. The curves shown in Figure 1 were developed for this purpose.

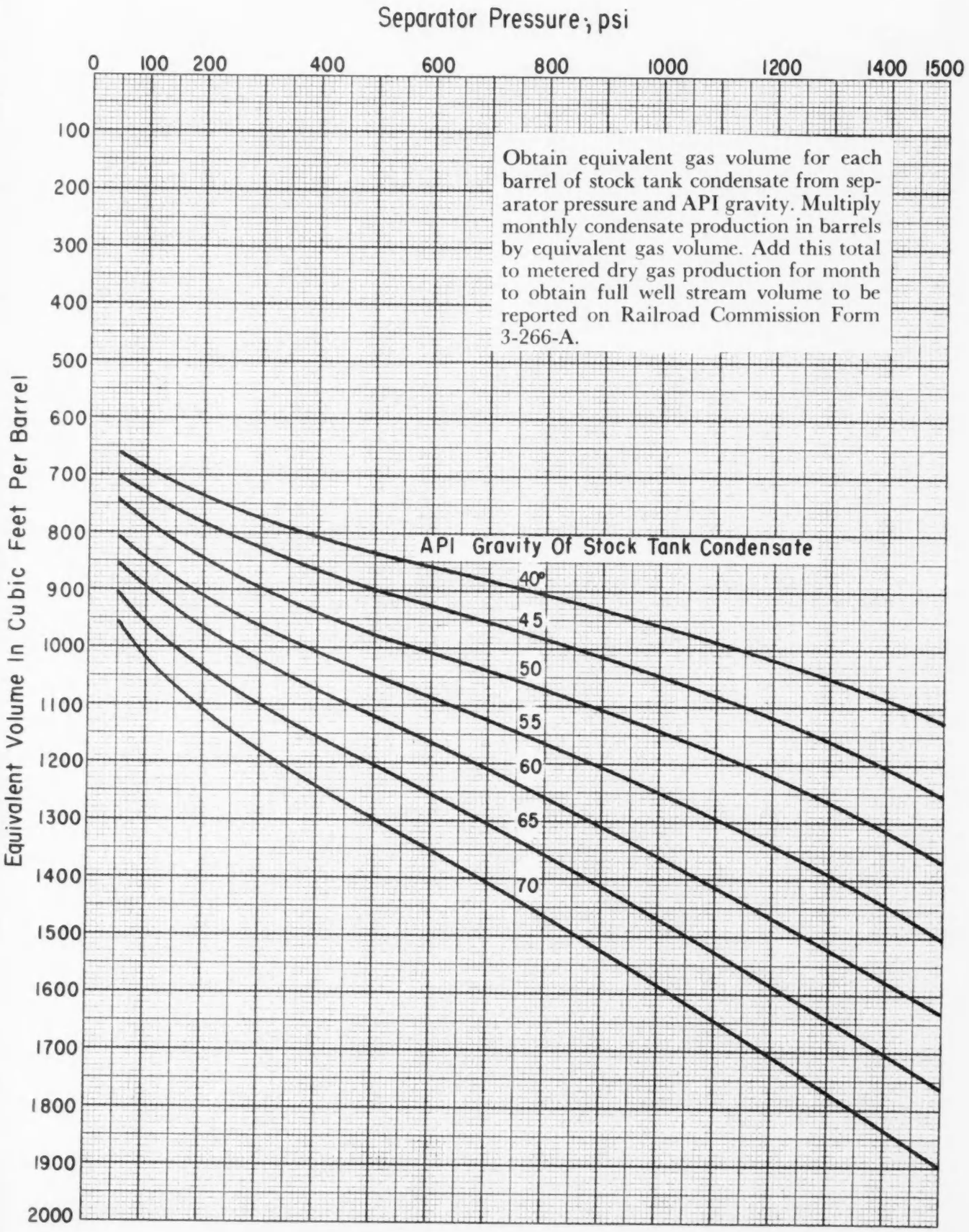
The curves provide an easy means for estimating equivalent gas volumes of stock tank condensates. The equivalent gas volume then can be added to the metered residue gas volume to obtain the full well stream volume. The only information necessary for use of the curves is lease separation pressure and API gravity of the stock tank condensate. The equivalent volume obtained includes the gas vented from low pressure separators and gas flashed at reduction of pressure into the stock tanks.

The conversion of stock tank condensate to equivalent gas volume was based on data appearing in Table 13.9, Page 708, Volume II of U.S. Bureau of Mines Monogram 10. This data was then combined with data obtained from solubility tables published by Beal[1] which were used to estimate the amount of gas that was in solution in the condensate at separator conditions and subsequently liberated at stock tank conditions.

LITERATURE CITED

[1] The Viscosity of Air, Water, Natural Gas, Crude Oil, and Its Associated Gases at Oil-Field Temperature and Pressures, Beal, A.I.M.E. Trans. 1946, Vol. 165.

equivalent gas volume of stock tank condensate



Time-setting clay cement controls lost circulation

This new material is very effective against small natural fractures, multiple fracture systems and small cavernous zones

J. U. Messenger
Chemical Engineer
Mobil Oil of Canada, Ltd.
Calgary, Alta.

LOST CIRCULATION to permeable sands, gravel and to very small fractures can usually be controlled by the use of bridging or plastering agents that are added directly to the drilling fluid. However, when the nature of a loss zone is such that bridging agents are ineffective, some type of cementing operation must be used.

Several disadvantages of using common neat cement, gel cement or quick set cement for combating lost circulation zones are:

- Loss of rig time
- Danger of sticking pipe or deviating hole
- Adverse effects on mud properties
- No anticipating properties.

In view of these conditions a time-setting clay cement was introduced to the oil industry. This material has many properties for combating severe lost circulation, tendency to stick drill pipe, or contamination of drilling fluids. It is also easily prepared, placed and controlled as to the final properties of the slurry.

Several field applications of this material have been tried and the following conclusions resulted:

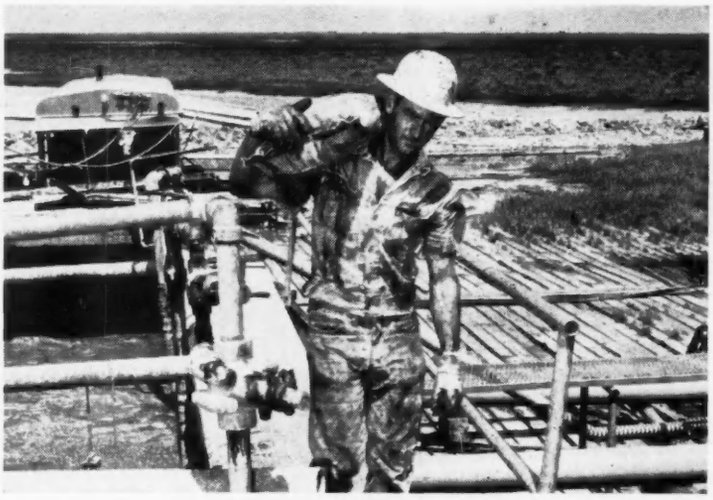
- The low water loss of clay cement slurry permits the application of this material against permeable zones with minimized possibility of changing the formation properties. Clay cement can also be squeezed into permeable sections of open holes without danger of flash setting and the attendant hazard of sticking pipe.
- The high gel strength of the slurry resists dilution or erosion by formation fluids and improves its displacing properties. This slurry property also prevents contamination by the drilling mud.
- The high initial gel strengths and rapid thickening rate permits the treatment of several zones in a wide interval of open hole in one operation.
- The low ultimate strength of clay cement limits the size of openings that can be effectively sealed. However, this low strength also permits easier removal of the plug from the hole with less danger of deviating the hole and eliminates the possibility of sticking pipe with set cement.
- Clay cement does not provide any anticipating protection and it is not recommended for use against loss zones that can be bridged or plastered with common drilling mud additives.
- Where mud losses into induced fractures and small natural fractures involve weighted muds, particularly if they are being maintained by centrifuging, the application of clay cement, without first testing bridging agents, could easily be the most effective and economical.
- Clay cements have been used most effectively against induced fractures and small natural fracture systems.
- Clay cement alone should not be used for support of casing. A plug that successfully seals off a loss zone under open hole conditions may be broken down by the movement of pipe during a drilling operation.
- Clay cement has been used successfully with conventional cement to seal large caverns and multiple fracture systems. The primary function of the clay cement in these operations is to form a temporary restraining bridge that confines the portland cement and isolates it from contaminating borehole and formation fluids.
- The squeeze pressure developed during the placement of a lost circulation material should be controlled carefully so that excessive pressures are not exerted against the loss zones or upper hole. A positive annular squeeze pressure is a sign of a successful job.

Properties and application of time-setting clay cement. Time-setting clay cement consists of a specially selected clay, a smaller amount of aluminum silicate and a retarder. The clay in this mixture has a unique tendency to time-harden when hydrated. Aluminum silicate is used to increase the strength of the set clay cement and a retarder is used to increase the pumping time of the slurry during placement. Initial slurry properties, thickening characteristics and final set strengths are primarily a function of slurry composition (concentration of clay cement solids) and the temperatures encountered during application. Much control over the final properities of clay cement can be obtained by variation of slurry composition and placement procedure.

The many characteristic properties of clay cement can be used to advantage in combatting severe lost circulation. The low water loss properties and high gel strength of clay cement slurries are of particular value in obtaining effective placement. Low water loss slurries can be squeezed against highly permeable zones without danger of flash setting and attendant hazards of sticking pipe. High gel strengths reduce the extent of mixing or dilution with other fluids. This last property, which permits an effective displacement of drilling fluids and formation fluids, is of primary importance in obtaining an effective plug of treating material in a loss zone.

As a clay cement assumes formation temperature, the gel strength of the slurry increases rapidly to a very high value. It becomes a plastic-like material with sufficient strength, in most cases, to give a permanent seal against lost circulation. Because of the high gel strength and rapid thickening properties of clay cement, this material can be placed and maintained in many zones where more conventional cements cannot be used. The very low ultimate strength of this material does limit its use where wide fractures or

Watch that can. It's dented already. The lid could pop—spill caustic all over clothes and body. Bad burns!



Love that easy handling. Diamond caustic bag much easier. Doesn't strain a man's back. Won't open till you open it yourself.

Pouring's tricky business. In drums, lumps caused by dampness often cause splashing—splashes burn mighty bad.

Bags are safer—pour evenly every time. Heat-sealed polyethylene inner bag keeps out moisture indefinitely. Burlap exterior bag easy to grab.

SAVE YOURSELF

SPECIFY DIAMOND® FLAKE CAUSTIC SODA IN BAGS

For further information, contact:
DIAMOND ALKALI COMPANY, 300 UNION COMMERCE BLDG., CLEVELAND 14, OHIO

Drilling rig photos at Houston Bay, Texas

Just burn it. Every Diamond bag can be destroyed almost instantly . . . doesn't have to be buried or trucked away.

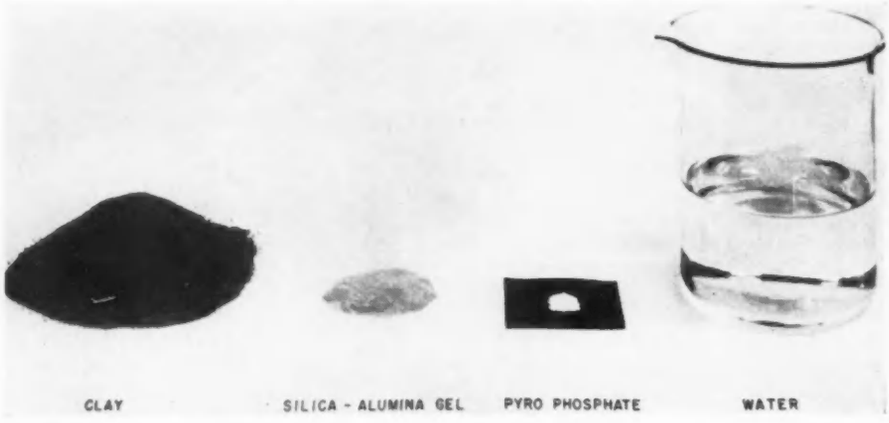


FIGURE 1—Here is the material and final product of time setting clay cement as developed under laboratory conditions.

large pressure differentials are encountered. However, clay cement can often be used in combination with conventional cements to give permanent protection against these types of severe loss zones.

It is often difficult to determine the amount of clay cement to use in a lost circulation treatment. Field experience to date has indicated that approximately six times the volume of hole adjacent to the loss zone is usually sufficient. However, there are wide variations among loss zones and local application experience is probably the best guide for choosing effective amounts.

The volume of clay cement required to obtain a successful plug will depend upon such variables as the dimensions and shape of the sink openings, the magnitude and direction of the pressure differential across the plug and the ultimate strength of the set cement. If these variables are known, clay cement requirements can be estimated by the following approximations. The volume of clay cement required to withstand a given pressure differential under conditions of linear displacement between two planes separated by a width W (as in a vertical fracture) is given by:

$$V = \frac{hW^2}{2\phi} \Delta P \qquad (1)$$

where V = volume of plug, cubic feet
h = height of plug or fracture, feet
W = width of plug or fracture separation, feet
ΔP = pressure differential across plug (difference between formation pressure and well-bore pressure), psi
ϕ = shear strength of clay cement plug, psi

Similarly, if the radial extent of the plug is large compared to the well-bore radius, the volume of a clay cement "pancake" in a horizontal fracture required to withstand a given positive pressure differential (excess pressure in the well bore) can be approximated by the relationship:

$$V = \frac{\pi W^3}{4\phi^2} (\Delta P)^2 \qquad (2)$$

For a negative pressure differential, with the same geometry, an approximation for the volume of clay cement required is:

$$V = \frac{\pi W^3}{4\phi^2 \left(1 + \frac{W}{2r_w}\right)^2} \qquad (3)$$

where r_w = well bore

According to the above relationships, for a set plug with a shear strength of 2 psi subjected to a pressure differential of 350 psi, all fractures or openings up to 6 inches in width can be successfully sealed with reasonable amounts of clay cement (less than 200 barrels, or about 400 to 500 sacks), regardless of the configuration of the thief zone. However, as shown by the above equations, clay cement requirements increase rapidly with fracture width, and for larger openings it is generally concluded that normal treatment volumes of clay cement are not effective in maintaining a shut-off. For severe loss zones, where openings are expected to exceed 6 inches in thickness, it is recommended that clay cement and portland cement be used alternately.

Time-setting clay cements are easily prepared and placed with standard cementing equipment wherein the clay cement solids and water are mixed in a jet hopper and then pumped directly into the drill pipe. Slurry weight, which is an important control factor, can be satisfactorily adjusted with this conventional slurry preparation technique. It is also possible to mix and place clay cement with regular mud pumps but this procedure is not as flexible as the use of cementing equipment. Although equipment has more or less been standardized, many different procedures have been developed for the actual placement of time-setting clay cement, as will be illustrated in the following discussion on recent field applications of this material.

Field applications. Time-setting clay cement has been used successfully to seal off many loss zones that could not be controlled by more conventional methods. Data are given in Table 1, which describe the application of clay cement in 36 field operations. Information listed in this table includes the location and depth of the wells, the depth and temperature of the loss zones, the mud densities and amount of mud loss before and after treatment, the amount and density of the clay cement used, the amount of clay cement squeezed into the loss zone and the maximum squeeze pressure held on the casing. Attempts were also made to determine the size and type of the loss zones through geologic studies of the formations involved, observation of cuttings and behavior of drilling equipment. The field trials included in Table 1 are grouped according to the predicted nature of the loss zones treated.

In all treatments presented, the clay cement was mixed and placed through drill pipe using conventional cementing equipment. The drill pipe was run open-ended to a point opposite the loss zone and the clay cement slurry displaced against the loss zone. If mud returns were obtained, the blowout preventers were closed and the clay cement was squeezed into the loss zone. (If the amounts of clay cement placed are not large enough to obtain returns, one third of the clay cement can be displaced and the hole slowly filled through the fill-up line. If it stays full or flows, the rams should be closed.)

Induced fractures and small natural fractures. The majority of clay applications in the field have been against induced fractures or small natural fracture systems. The physical properties of this material appear to be suited for use against these loss zones. Clay cement slurries can be

Installed on caustic lines in 1930, these Rockwell-Nordstrom lubricated plug valves needed only cleaning before installation in new plant.

THE VALVES THAT WOULDN'T RETIRE

The Rockwell-Nordstrom lubricated plug valves shown above were two of dozens installed in 1930 on caustic lines at a process plant. When the plant was torn down in 1959, the valves were still in such good condition that they're being used on the same service in the new plant.

The above story is just one more example of the ruggedness of Rockwell-Nordstrom valves. Since they're sealed positively against leakage by pressurized lubricant and there are no exposed metal-to-metal seats, you get positive shut-off year after year. And, lubrication is preventive maintenance against the high cost of repairs, replacement and downtime. To get complete details on Rockwell-Nordstrom, the original and world's most complete line of lubricated plug valves, lubricants and accessories, write: *Rockwell Manufacturing Company, Pittsburgh 8, Pa.; Canadian Valve Licensee: Peacock Brothers Limited, Montreal, Quebec; Rockwell International S.A., Geneva, Switzerland.*

Lubrication Makes The Difference

ROCKWELL-Nordstrom VALVES

another fine product by

ROCKWELL

These 175-lb WOG Rockwell-Nordstrom valves have already given years of trouble-free service on production header controlling 16 wells in West Texas lease.

placed easily into these fractures and the high gel strength restricts the transfer of fluid pressure from the bore-hole to the fluid in the fracture. This gel property is of particular value in restricting the propagation of induced fractures. Set clay cement is usually strong enough to maintain a permanent plug in most natural fracture systems and is plastic enough to deform in induced fractures. Since the dimensions of induced fractures are directly related to internal rock stresses, they will vary with changes in pressure forces exerted against the formation. Set clay cement is plastic enough to deform easily with changing loads (breathing seal principle) and as a re-

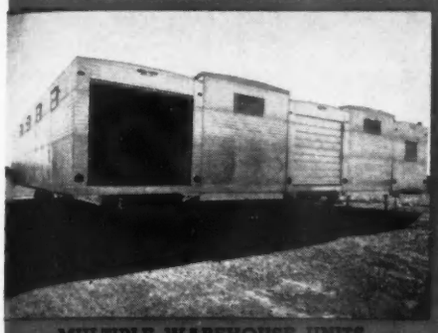
TABLE 1—Numerous Tests Are Shown Above Whereby Time-Setting Clay Cement Was Used to Combat Varying Types of Lost Circulation Zones

Field Application Number	Location of Well	Total Well Depth, Feet	Estimated Depth of Thief Zone, Feet	Estimated Formation Temperature, °F	Nature of Thief Zone	Mud Loss, Percent		Mud Density, lbs./gal	Am't Clay Cement Applied		Am't Clay Cement Placed with Rams Closed, bbls	Slurry Density, lb/gal	Maximum Squeeze Pressure on Casing, psi	Remarks
						Before	After		Sacks	Bbls				
									75	31	27	11.9	0	
1	Neva West Field, Texas	490	459-490	80	Fractures	100	None	8.5	125	48	45	12.1	0	Staged in two parts.
2	Kankakee, Ill	1,165	1,160-1,165	100	Fractures	100	None	...	80	20	17	12.7	0	
3	Kankakee, Ill	1,336	1,280	100	Fractures	100	None	9.0	80	30	0	11.8	325-600	Annular squeeze from top
4	Ariola Field, Texas	1,800	1,800	100	Fractures	100	None		100	45	42	11.6	....	
5	Clam Lake, La	2,000	2,000	100	Fractures	100	None	12.0	120	50	45	11.8	....	
6	Woodlawn Field, Ill	3,685	2,523-2,550	115	Fractures	100	None		70	24	21	12.5	0-75	Annular squeeze from top.
7	Bexar Co., Texas	2,733	2,678-2,733	115	Fractured Limestone	100	None	...	120	50	0	11.8	....	
		2,751	2,739-2,751			100	None	...	120	47	40	12.0	....	
8	Dell City	2,869	2,869	115	Fractures	100	None	...	200	80	0	12.0	....	
9	Jeanerette, La	11,408	2,896	130	Fractures	100	None	12.1	35	20	17	10.8	0-200	Well kicking.
10	Hinds Co., Miss	3,087	3,085-3,087	130	Fractured Chalk	100	None	...	111	44	38	11.7	....	Placed through bit.
11	Midland, Mich	3,700	3,540	130	.....	100	10	10.5	120	50	45	11.7	0	
						90	None	...	110	40	15	12.2	....	
12	Barbers Hill, Texas	4,100	1,480-1,520	105	Fractures in Salt	100	100	10.8	108	45	38	11.6	....	Increased mud density to 11.0.
			3,645	135		100	100	10.8	198	84	64	11.6	....	
13	Flo Field, Texas	7,338	5,278-5,317	130	Broken Shale	100	None	10.5	112	50	35	11.6	125	
14	Mykawa Field, Texas	6,444	5,503	130	Fractures	100	None	14.0	117	51	35	11.8	0	Decreased mud density to 10.5.
15	Louisiana	6,090	5,955	170	Fractured Lime	100	None	10.0	70	30	27	11.7	350	
		6,196	5,955			100	None	...	70	30	27	11.7	250	
16	San Ramon Field, Texas	8,327	2,600	140	Fractures	100	None	14.9	100	41	0	11.9	0	
			6,064	190		100	None	...	100	41	0	11.9	0	
17	Roberts Co., Texas	6,772	6,410-6,500	180	Fractured Arkose Limestone	100	100-0	8.7	117	50	33	11.7	0	Bit was run 5 stands below top of clay cement.
			6,260-6,425											
			6,226-6,458			100	100	...	234	103	56	11.7	150-0	
			5,950-6,250			100	10-100	...	226	101	83	12.1	85-45	
18	Ariola Field, Texas	6,800	6,800	170	Fractures	100	None	...	120	50	45	11.8	....	
19	Rachel, Texas	7,332	6,972-7,332	175	Broken Sandy Shale	10-100	100	15.5	114	50	47	11.6	250-0	
			6,972-7,332			10-100	100	...	113	50	50	11.6	400-0	
20	Galveston Bay, Texas	7,837	7,800-7,837	200	Fractures	100	100	14.4	100	50	..	11.2	....	
			3,900	135	Broken Shale	100	100	...	60	30	..	11.2	....	Decreased mud density to 13.2.
			2,541	115		100	100	...	200	100	..	11.2	....	
			2,500	115		100	None	...	200	100	..	11.2	....	
21	Monte Alto, Texas	10,800	9,125	225	Fractures	100	None	16.0	100	50	..	11.2	450	Mud density increased to 16.7.
22	East White Lake, La	12,116	10,332-10,363	245	Leaking Casing Perforations	100	None	15.7	33	14	11	11.6	0	Mud density increased to 17.0.
23	Chocolate Bayou Field, La.	11,568	11,393	200	Fractures	100	None	...	38	18	15	11.4	600	
	Brazoria Co., Texas	11,590	11,590			100	100	...	48	21	18	11.6	400-0	
		11,590	11,590			100	None	...	63	28	20	11.6	650	
24	Chalky Field, La	8,270	6,570	166	Fractures	100	None	14.3	90	44	14	11.3	150	
		8,423	8,270	180	Unconsolidated Sand and Shale	100	100	13.1	50	24	..	11.3	0	Mud density increased to 14.2.
			6,320	162		100	None	13.1	155	76	..	11.3	100	
		11,507	9,240	203		100	None	18.1	95	50	23	11.0	450	
			10,800	225		100	100	18.1	84	45	0	11.0	0	Clay cement set up in drill pipe.
			10,795	225		100	None	18.1	65	35	35	11.0	300	
		11,804	11,000	230		100	None	18.1	56	30	30	11.0	0	
			11,692	240		100	None	18.1	60	32	..	11.0	....	
25	Saline Co., Kansas	3,095	2,923-3,095	120	Fractured Limestone	100	100	...	35	14	...	11.6	....	
			2,970			100	100	...	100	40	...	11.8	....	
			3,070			100	100	...	65	25	..	12.0	....	
26	Marfa, Texas	4,980	4,920-4,980	150	Fractures	100	100	...	50	20	...	12.2	....	
						100	100	...	50	16	..	12.7	....	
						100	100	...	25	25	...	12.8	....	
						100	100	...	100	25	...	13.0	....	
						100	100	...	100	25	...	13.0	....	
27	Hobbs, New Mexico	8,652	8,652	215	Fractures	100	100	...	208	65	...	12.4	....	
28	Herscher, Ill	1,311	1,305-1,311	95	Fractures	100	100	9.2	80	38	35	11.4	0	Five barrels of crushed limestone poured down hole.
					Water Flowing from Sand at 185 feet	100	100	9.2	80	33	30	11.8	0	
						100	None	9.2	80	28	21	12.4	0	
						100	None	14.0	80	40	20	11.2	500	
29	Darst Field, Texas	2,638	2,638	115	1'-4' Cavern, Moving Fluids	100	25	9.5	200	84	0	11.8	0	
30	Luling Field, Texas	2,764	2,748-2,752	100	2'-4' Cavern, Moving Fluids	100	100	9.5	200	78	0	12.0	0	Clay cement was staged alternately with 100 sacks of gel cement.
						100	None	...	200	72	0	12.0	....	
31	Sweetwater Co., Wy	1,531	1,531-1,533	....	1'-2' Cavern, Moving Fluids Formation Slant of 65°	100	100	8.9	125	55	0	11.8	0	
32	Driver Pool, Texas	4,200	4,200	120	1'-5' Cavern, Moving Fluids	100	100	9.2	70	25	0	12.0	0	Contained equal volume of perlite, slurry plugged drill pipe.
33	Driver Pool, Texas	4,200	4,200	120	1'-5' Cavern, Moving Fluids	100	100	9.8	115	50	0	11.0	0	
						100	100	...	300	120	0	12.0	0	
34	Driver Pool, Texas	4,210	4,183-4,190	120	4'-7' Cavern, Moving Fluids	100	100	8.7	100	47	0	11.5	0	
						100	100	8.7	100	47	0	11.5	0*	
						100	100	8.7	125	60	0	11.5	0	
35	Cloudcroft, N.M.	825	350	65	Multiple Fractures	100	100	8.6	200	100	0	11.0	0**	
		3,200	1,400	88		100	None	8.6	200	100	0	11.0	0	Clay cement to hold cement. Amounts placed insufficient.
36	Kent, Texas	764	760-764	80	Multiple Caverns	100	100	8.5	100	35	0	12.2	0	
		792	783-792	80		Subsequently opened by drilling blind.								
		807	802-817	80		Subsequently opened by drilling blind.								

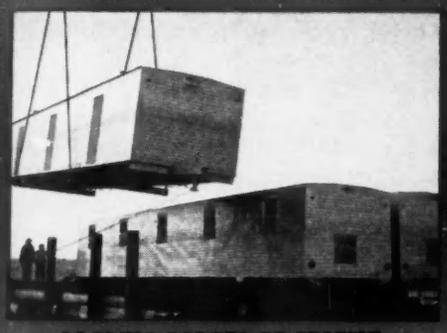
* No attempt was made to plug zone with clay cement; it was used to hold gel cement around well bore and to protect it from salt water entering the loss zone from an upper sand. All materials mixed with 2-3 percent gel water.

** All materials mixed in 3 percent gel water. Obtained circulation but lost drilling out. Loss zone believed to be up around shoe. Second job run alternately with cement and gravel.

INDUSTRIAL TRAILER CAMPS



MULTIPLE WAREHOUSE UNITS



LOADING BARGES AT SEATTLE

PALLETIZERS ENROUTE TO LIBYA

KITCHEN CAR INTERIOR

WASH CAR INTERIOR

BUNK HOUSE INTERIOR

northland camps inc.

Write or Call:

- **IN THE U.S.A.**
  Northland Camps Inc.
  1331 - 3rd Ave. Jones Building
  Phone **Main 34083**
  SEATTLE, Washington.
- **IN CANADA**
  Alberta Trailer Co. Ltd.
  805 - 3rd Street N.E.
  Dept. K. Phone **AM 3-2130**
  CALGARY, Alberta
- **IN THE MIDDLE EAST**
  Spinney's (1948) Limited
  P.O.B. 746 Beirut Lebanon
  and in Libya, Kuwait,
  Aden, Iraq, Pakistan.

● ALL TYPES AND SIZES
● FOR RENT OR SALE
● ANYWHERE IN THE WORLD!

Northland Camps Inc. provides a complete industrial trailer service . . . including the design and construction of special units . . . transportation by a fleet of specially designed trucks . . . site preparation . . . plus catering by their new Food Service Division.

All units are easily erected and dismantled, ruggedly constructed and insulated to withstand extremes of heat and cold. Regular units include Bunkhouses, Kitchens, Diners, Wash Cars, Deep Freezers, Preparation Cars, Warehouses, and Power Units . . . all available for immediate delivery.

Largest Manufacturer of Industrial Trailers in the world!

COMPLETE PACKAGE UNITS
N.C.I.'s "One-Stop-Rental Service" provides fully integrated camp facilities.

sult will tend to maintain intimate contact with the confining fracture surfaces.

The first 27 field trials listed in Table 1 are examples of clay cement treatments applied to induced fracture or small natural fracture systems. Fluid losses in all these wells were relatively severe and could not be controlled by conventional methods. Of these, a total of 21 successful seals was obtained with clay cement. The exact cause for failure in the remaining six wells is not known but it is believed that more effective seals could have been obtained with different placement procedures. To be effective, a lost circulation material must be supplied in sufficient quantity and to the proper location in the bore hole. Failure in either of these requirements will result in an unsuccessful treatment. Data are incomplete for three of the test wells (25, 26, 27) and no evaluation of causes for failure can be given. However, there is a possible explanation for failure in the remaining three wells (12, 17, 19). In each of these wells a positive annular squeeze pressure was developed indicating an apparently successful seal. However, upon further increase in the squeeze pressure, circulation was lost and the annular pressure dropped to zero. It is possible that excessive annular squeeze pressures were used in these wells and that these pressures produced new fractures that were either inaccessible to the clay cement or were too extensive to be effectively plugged with the amount of material that was applied. In the treatment of easily fractured zones, it is recommended that a maximum pressure be established, based upon anticipated working pressure requirements, and that every effort be made not to exceed the predetermined pressure limit during the placement operation. This technique protects other potential loss zones and the weaker upper formations.

Another possible cause for ultimate failure in the treatment of induced fracture zones is the improper removal of the set clay cement from the borehole. Rapid penetration of the plug can produce pressure surges sufficient to create new fractures. Penetration to too great a depth without drilling or washing must also be avoided. Although the plastic-like material is relatively soft and easily penetrated, large pressure differentials are required to make it flow. Downhole pressures required to circulate out large volumes of set clay cement could easily be sufficient to induce formation fractures.

Large fractures, solution channels and caverns. The problems associated with the loss of fluid to large fractures or caverns are extremely difficult. Often drilling operations must be completely suspended when these severe loss zones are encountered. Time setting clay cement has been used with some success but in general the properties of this material are not suited to treatment of these zones. The high gel strength of clay cement slurries does enhance effective displacement of formation fluids but the set strengths of the material and the strength of its bond to the formation are usually not sufficient to maintain a permanent plug in large openings. The requirements for successful treatment are further complicated by the fact that most large fractures or cavernous zones are encountered at depths characterized by low temperatures and pressures. High density clay cement mixes are necessary to give satisfactory set strengths at low temperatures. Under these conditions it is difficult to place a clay cement slurry that will remain in the vicinity of the bore hole.

Of the field tests listed in Table 1, nine of the loss zones treated (28 through 36) can be classified as large fractures or caverns. It is noted that all of these severe loss zones are located at relatively shallow depths and have low temperatures. Only one of the zones (28) was successfully plugged with clay cement alone, and the actual size of the fractures in this well is in doubt. Three other wells (29, 30 and 31) were sealed using clay cement in conjunction with conventional gel cement.

Evaluation of the field performance of clay cement in severe loss zones makes it apparent that this material, used alone, is usually ineffective. Applications against large slanting fractures and caverns (32 through 36 and 38) have been completely unsuccessful. On the other hand, there is evidence that clay cement can be used with some success as a temporary restraining plug for conventional cements. There appear to be many possible applications of clay cement as a plugging material for control of fluid movement around a borehole.

Applications and operation procedures. Considerable operational experience has been gained from the numerous field applications of clay cement. The merits of this unique material have been weighed against its apparent shortcomings. A natural outcome of these field tests has been the development of many special opering techniques and placement procedures. A few of these developments are discussed below.

1. Removal of clay cement plug. The ultimate success of a clay cement treatment may well depend upon the procedures used in removing the plug from the hole. This material must be circulated out without the development of excessive borehole pressures. Penetration rate of the bit must be controlled and fluid circulation maintained. One recommended procedure is as follows: run the bit to the shallowest possible depth to which the clay cement could have come or preferably to the measured top as determined by a wire line. Set clay cement is too soft to permit the location of the top of the plug by pipe weight measurements. After the plug is located, pick up the kelly and drill it down. Next, run in another stand and work it up and down once, then pick up the kelly and the string as far as possible and carefully engage the pumps. If full circulation is established, slowly wash in the joint above the rotary. After the washing operation, the kelly is again drilled down and the above procedure repeated until the entire plug is circulated out. Using this method, all but 20 feet of a 90-foot piece of clay cement plug is either drilled or washed. As a precaution the plug could be drilled a joint at a time near the actual loss zone.

2. Use of clay cement behind casing. Although clay cement is just as effective in correcting lost circulation behind casing as it is in open hole, the set strength of this material is usually not sufficient to support casing during a drilling operation. A plug which would normally hold in an open hole may be broken down and caused to fail by the movement of pipe. This is particularly true if the clay cement plug in the annulus is sufficient only to prevent loss circulation and does not extensively fill the loss zone. For treatment of loss zones behind casing is is recommended that a strong cementing material be used to support the casing. If an initial seal cannot be

New way to control lost circulation

Starts on Page 110

FIGURE 2—The consistency of time-setting cement after it had been recovered from the drill pipe at a depth of 7,000 feet.

obtained with a conventional cement, it can be applied alternately with clay cement.

3. Control of fluid motion during placement. Probably the most common cause for the failure of cement as a lost circulation material is contamination or the displacement of the slurry away from the borehole before it has time to set. Control of fluid movement in the vicinity of a loss zone is of particular importance for the successful application of slow-setting materials. The use of drop plugs and partial displacement of cement are common techniques used to hold cement plugs around the well bore. However, steps are rarely taken to prevent the breakthrough of fluids raised in the annulus during displacement or the mixing of contaminating fluids with the treating material during placement.

The properties of clay cement can be used to advantage in controlling fluid movement in a bore hole or loss zone. The placement technique especially designed for the treatment of Well No. 34 may illustrate this application. In this well it was thought that a 4- to 7-foot slanting cavern was open between 4,183 and 4,190 feet. It was estimated that about 200 barrels of salt water per day were fed into this zone from an upper sand at 1,500 feet. For treatment, open-end drill pipe was initially run to a depth of 3,490 feet and 75 sacks of clay cement (mixed with a 2 wt. percent bentonite slurry) was displaced into the hole. When the clay cement slurry reached the end of the pipe, displacement operations were suspended for five minutes to allow for equalization of fluid heads. Four stands of pipe were then run which placed the end of the pipe well below this plug of clay cement slurry. The actual treatment of the loss zone was accomplished from this level. High early strength gel cement (600 sacks) was preceded by 25 sacks of clay cement, with separation being maintained by a wiper plug. A waiting period was allowed for the equalization of pressure when the clay cement reached the end of the pipe. The gel cement slurry was followed by an additional 25 sacks of clay cement, which was only partially displaced before the pipe was withdrawn from the zone.

Throughout the operation, time was allowed for pressure equalization after each pipe movement or fluid displacement. This procedure was taken to prevent the fluid heads from producing flow within the well bore. The function of the initial clay cement plug placed up-hole from the loss zone

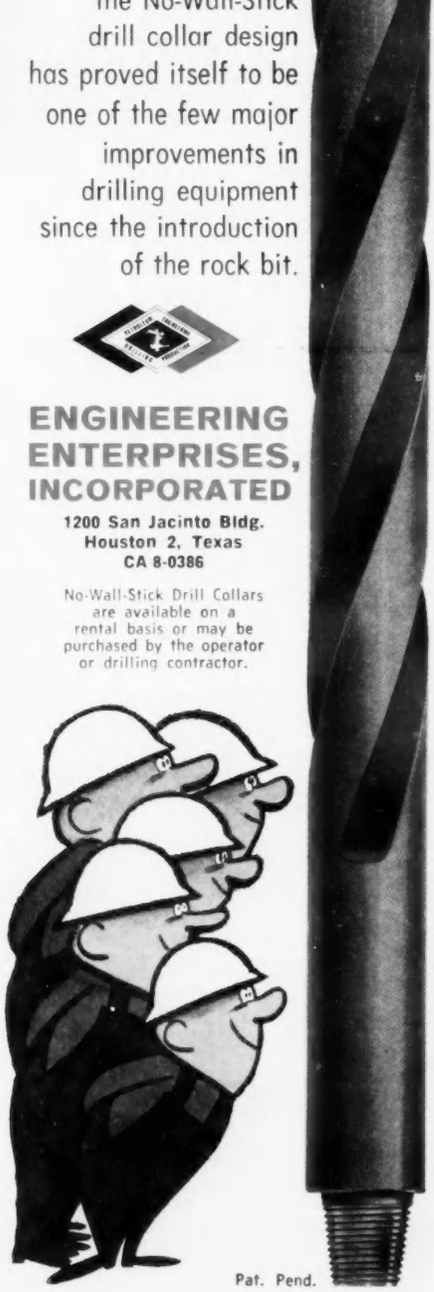
No-Wall-Stick Drill Collars Being eyed by the drilling industry

In the past year the No-Wall-Stick drill collar design has proved itself to be one of the few major improvements in drilling equipment since the introduction of the rock bit.

ENGINEERING ENTERPRISES, INCORPORATED

1200 San Jacinto Bldg.
Houston 2, Texas
CA 8-0386

No-Wall-Stick Drill Collars are available on a rental basis or may be purchased by the operator or drilling contractor.



Pat. Pend.

PRECISE BOTTOM-HOLE ORIENTATION *in minutes*

WITH THE

NEW REGAN BOTTOM-HOLE ORIENTING SUB

★ *Cuts Rig Time*

★ *Maintains Continuous Mud Circulation*

★ *Eliminates use of Sand Line and Instrument*

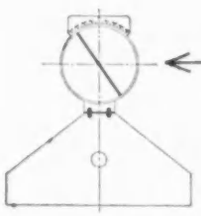
Ease of operation . . . fastest, most precise bottom-hole orientation in the drilling industry . . . all these benefits are yours when you use the Regan Bottom-Hole Orienting Sub. Field tested for nearly three years in holes up to 12,000 feet by major California drillers, this great new tool is now ready to bring its positive advantages to industry-wide drilling operations.

Featuring a pre-set splined jar one single above the deflection tool, the jar is tripped by a gravity-actuated ball. It indicates *at the surface* the correct tool orientation by shortening the drill string the length of the jar. *At no time does the ball support any weight to bind its movement or damage its race.*

For dependable hole insurance, plus fastest and most precise deflection tool orienting, check into the Regan Bottom-Hole Orienting Sub—soon.

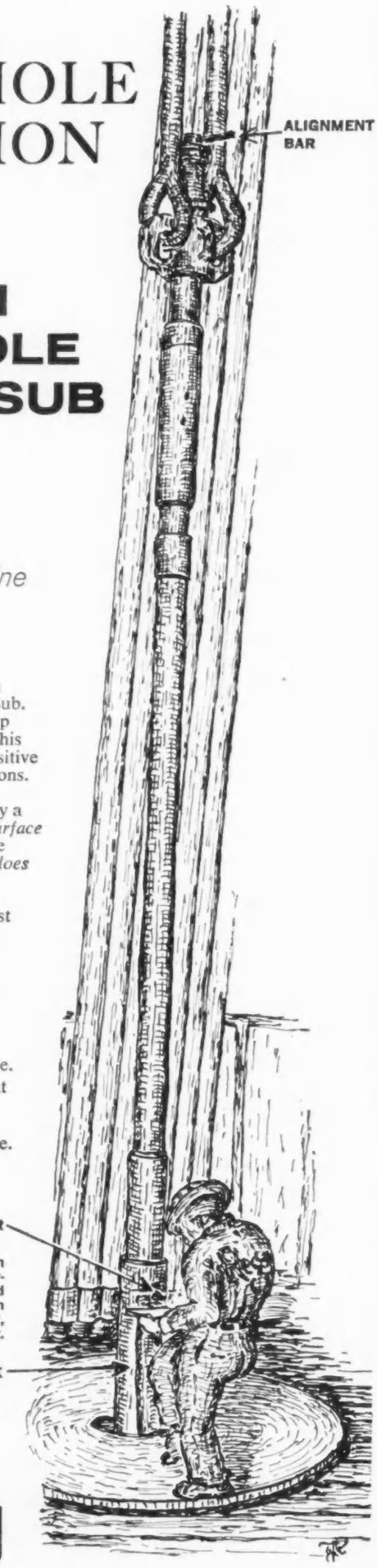
Advantages of deflection tool orientation from the *bottom* of the hole:

1. Absolute accuracy within closest tolerances.
2. Continuous mud circulation for a safe hole.
3. Elimination of time-consuming instrument runs; use and wear of sand lines.
4. Will repeat setting as many times as necessary without removing tool from hole.



PROTRACTOR

Protractor is placed on whipstock face with hair-line on mirror aligned with the alignment bar in orienting sub for fast, precise surface setting.



For full particulars, write to:

Regan® Quality — Forge & Engineering Co.

P. O. BOX 150 SAN PEDRO, CALIF.

New way to control lost circulation

Starts on Page 110

was to prevent flow of the salt water into the lower zone during treatment. Clay cement was pumped into the loss zone ahead of the gel cement to displace salt water in the zone and to form a temporary restraining plug. The purpose of the third application of clay cement was to provide an additional seal against salt water behind the conventional cement and to form a plug in the drill pipe so that it would be pulled wet. The basic reason for withdrawing the pipe wet was to reduce the hydrostatic pressure exerted against the loss zone. Under this condition the pressure differential across the loss zone is more favorable for maintaining the treating material in the vicinity of the bore hole. Even with these precautions, no plug remained in the well bore until a blanked-off sub with ports directed upward was placed on the end of the drill pipe.

4. Treatment of multiple fracture zones. Multiple fracture systems are usually characterized by repeated breakdowns and lost circulation at different fluid pressure levels. Fluids are lost to the weakest zone until it can be successfully plugged, after which circulation can be maintained until another zone is broken down. With repeated treatments it is usually possible to seal off entire multiple fracture zones, provided the material used is effective in plugging the individual fractures. Clay cement used in combination with portland cement can be used effectively in this type of treatment. The initial placement of clay cement followed by regular cement should be at zero pressure or at the minimum pressure required to displace the material into the loss zone. The function of this first application is to obtain an initial plug in the open areas and the most pressure-sensitive fractures. In the second treatment, the clay cement and regular cement should be squeezed into the loss zone at the next pressure level required to produce displacement. By repeating this procedure, it is theorized that the individual fractures of the zone can be systematically plugged. Sufficient time must be allowed between appli-

"Matched Tools for Unmatched Performance"

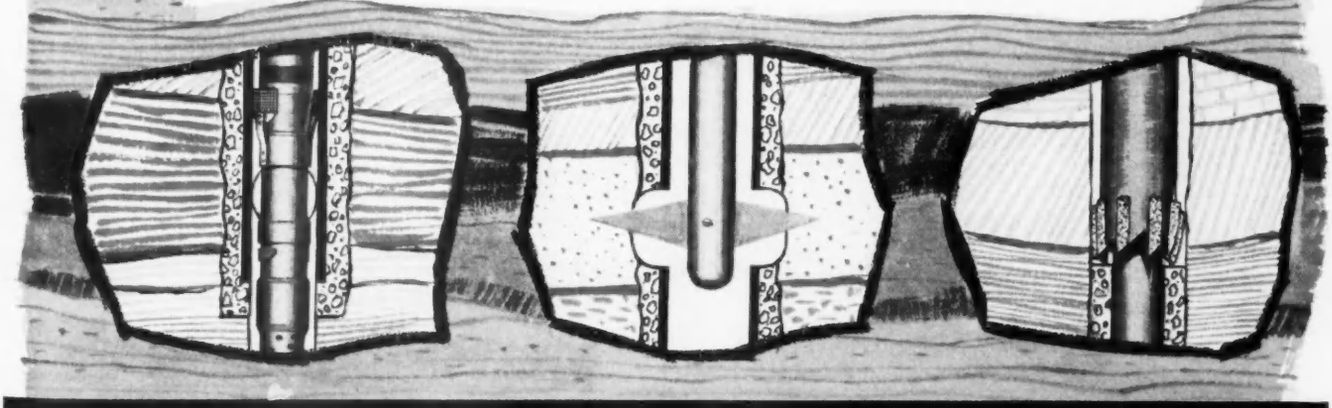
WHAT 42 YEARS OF SERVICE "KNOW-HOW" MEANS TO YOU

Whether your needs call for setting a liner, notching the formation, washing over stuck Drill Collars or any other service job, *BAASH-ROSS* service *"know-how"* coupled with top-engineered tools, such as the Power Swivel, means you are assured . . .

- That experienced servicemen will do the job right
- That the job will be done in the shortest time
- That you will realize the maximum in safety, quality and accuracy

These factors total up to the ultimate in *SERVICE PERFORMANCE* which means *SAVINGS* to you.

ONCE USED . . . ALWAYS DEMANDED



OVERSHOT

In addition to extensive service work, Baash-Ross fishing and drilling tools are available for rent. Be ahead by calling us for your Rental or Service needs.

INTERNAL PIPE CUTTER

BAASH-ROSS

DIVISION OF JOY MANUFACTURING COMPANY

General Offices: Houston, Texas

BAASH DIV ROSS

OUR 42d YEAR OF PROGRESS

JOY

Starts on Page 110

cations to permit the portland cement to harden so that subsequent treatments will not displace or break down the seals previously obtained. The overall treatment should be continued until a final squeeze pressure is developed that is slightly higher than anticipated operating pressures. Allowance should also be made for possible surge pressures that could be produced in subsequent operations.

5. Use of bentonite and other materials with clay cement. The properties of a clay cement slurry and set cement are closely related to the active solids concentration. As a direct result of this relationship, the density of the clay cement slurry used in a given operation is usually fixed by the overall treatment requirements. However, to permit successful placement, it is often necessary to change the density of a clay cement slurry without materially changing its physical properties. Prehydrating bentonite in the mixing water has been used with some success to reduce the effective density of clay cement slurries.

A number of other materials has also been used in conjunction with clay cement. Some granular bridging materials have been added to clay cement slurries, although this procedure seems useless since clay cement is normally used only after conventional bridging or plastering agents have failed. Inert solids that can alter slurry density or absorb water may have considerable application in clay cement treatment. Weighting material may be necessary in the treatment of deep loss zones, but has not been so far. When high temperatures are encountered, it is usually necessary to reduce the active clay solids concentration so that sufficient pumping time can be obtained for placement.

The author wishes to thank the Magnolia Petroleum Company and Mobil Oil of Canada, Ltd. for permission to publish this paper. Special thanks are given to the Magcobar field engineers who supplied certain of the data used. The assistance of I. R. Dunlap and M. D. Nelson in editing the paper and J. S. McNiel, Jr. in deriving Equations 1-3 is acknowledged.

—The End

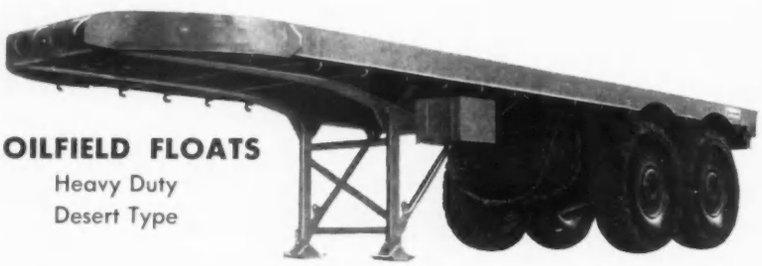
About the Author

Joseph U. Messenger is employed by Mobil Oil of Canada, Ltd., Calgary, as a chemical engineer. He has been working on drilling muds, cements, lost circulation, corrosion, injection waters and chemical problems associated with these fields. Messenger received his M.S. degree in physical and inorganic chemistry in 1942 from the University of Southern California. He is a member of the American Chemical Society and National Association of Corrosion Engineers.

FOR OIL FIELDS . . .

CAMP TRAILERS
Sleepers
Kitchens
Diners
Offices
Baths
Reefers, etc.

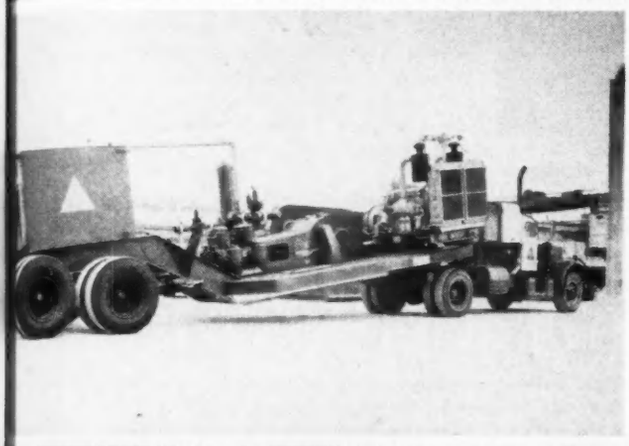
SKIDDED CABINS
All Models

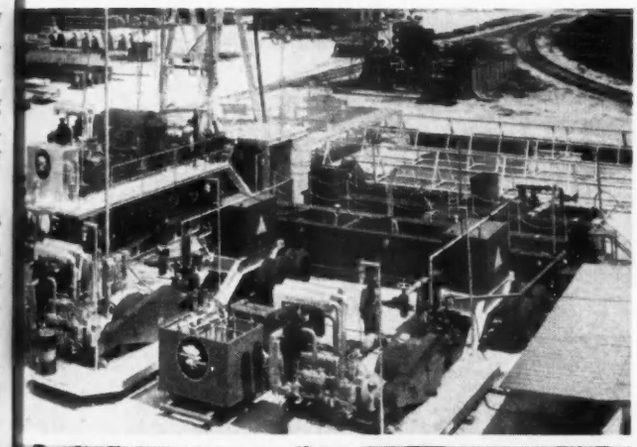


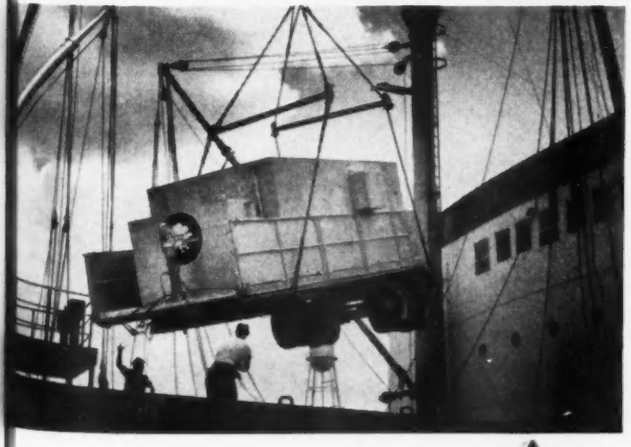
OILFIELD FLOATS
Heavy Duty
Desert Type

Blumhardt
GEBR. MUTHMANN

C. BLUMHARDT
WUPPERTAL-VOHWINKEL
P. O. BOX 37 GERMANY
Cables: cebluvo wuppertal







FROM DRAWING BOARD TO DOCKSIDE

RUGGED PORTABILITY of Continental-Emsco's T-97-250T Dual Trailer Drilling Rig answers the transportation problems posed by Spanish Sahara's barren wastes. Mast travels with rotary table in place and traveling block completely strung, ready for assembly with drawworks trailer. Time and expense of rigging up, tearing down and transporting are cut to a minimum.

SPECIAL PROBLEMS are quickly and efficiently solved at Continental-Emsco. Typical result is this "trailerized" slush pump, furnished for Falcon-Seaboard and now offered as standard equipment. In operation, trailer frame rests firmly on the ground, supporting engine and pump at a low level to assure flooded suction. It backs into position without jack-knifing the trailer. Tool houses, fuel and water tanks and complete mud system were designed and built by Continental-Emsco.

MONEY-SAVING ASSURANCE that rig is ready for service . . . that's Continental-Emsco's pre-overseas assembly. Every component is inspected, installed and tested. All piping is fitted at the plant. Any desired modifications are quickly, inexpensively handled. No costly delays occur when rig reaches a remote drilling area.

QUICK SHIPMENT to overseas destination is aided by Continental-Emsco's accessibility to Port of Houston. Complete packaging at the factory provides the best protection for materials en route. Special expediting team follows through on orders to speed delivery. Wherever you choose to operate, Continental-Emsco's big, capable, worldwide service organization adds *extra value* to your purchasing dollar.

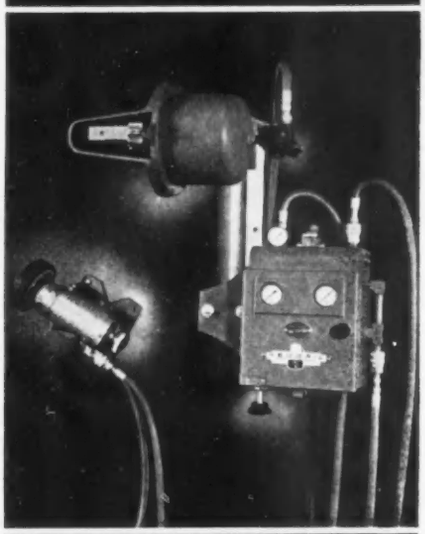
EX001 ®

CONTINENTAL-EMSCO

Serving the Oil and Gas Industries ... Worldwide

CONTINENTAL-EMSCO COMPANY • A Division of The Youngstown Sheet and Tube Company • General Offices: Dallas, Texas
Export Division: 30 Rockefeller Plaza, New York, N. Y. • Continental-Emsco Company Limited • General Offices: Calgary, Alberta, Canada
Continental-Emsco Company C. A., Caracas, Venezuela • Plants: Houston and Garland, Texas; St. Albans, Herts, England • Representatives in All Principal Oil Fields of the World

The NEW
GEODRIL®
AUTOMATIC
DRILLER



gives you

1. LONGER BIT LIFE
2. FEWER TRIPS
3. STRAIGHTER HOLE

The GEODRIL Automatic Drilling Control was developed, tested and proved in the field by The Geolograph Company, manufacturers of the internationally accepted Geolograph Mechanical Well Logging Recorder.

The new, automatic GEODRIL control has many outstanding features and offers the drilling contractor dependability, economy and safety.

Service for the GEODRIL Control is provided by the experienced personnel of Geolograph Oil Field Services. Their reputation for service is backed by over a fifth-of-a-century of experience in the oil fields.

When you drill your next well, specify the NEW GEODRIL Automatic Driller for maximum drilling efficiency. For additional information, contact your nearby Geolograph Oil Field Services office.

GEODRIL®
AUTOMATIC
DRILLER

GEOLOGRAPH®
OIL FIELD SERVICES
P O Box 1276 • Oklahoma City 1, Okla.

Your industry at work

A monthly roundup of items of interest about people, companies and associations

R. L. Kidd

J. E. Heston

Consolidation of Operations Announced By Cities Service

Cities Service Oil Co. (Del.), has announced plans to consolidate the operations of its domestic oil exploration, production and related activities, with headquarters in Bartlesville, Okla. It was anticipated that Cities Service Company would become the owner of all of the outstanding stock of Arkansas Fuel Oil Corporation on or about December 3, 1960. It is expected that consolidation of the operating activities will be undertaken shortly thereafter.

The consolidation program contemplates that Robert L. Kidd, now president of Cities Service Oil Co. (Del.), principal operating subsidiary of the Cities Service system, will become chairman of the board and continue as chief executive officer of that company. J. E. Heston, who has served as president of Arkansas Fuel Oil Corporation since 1956, will continue in that position and will also become president of Cities Service Oil Co. (Del.) with headquarters at Bartlesville.

Studies are now going forward concerning marketing operations of Arkansas Fuel Oil Corporation and other Cities Service subsidiaries, with a view to improvements and efficiencies which appeared impracticable until Arkansas Fuel became a wholly-owned Cities Service subsidiary.

Collateral College Grants Announced By Creole Corp.

Unrestricted grants to U.S. colleges and universities amounting to $41,200 have been announced by the Creole Foundation, established in Venezuela by the Creole Petroleum Corporation to support educational, scientific and cultural activities in that country.

Donations ranging in amounts from $500 to $3,000 are being awarded as collateral grants to institutions at which 67 scholarship students from Venezuela are currently enrolled. According to the spokesman for Creole, this is the fourth consecutive year Creole has announced these grants in recognition of the gap between tuition fees and actual costs of instruction.

Institutions receiving grants are: Bryn Mawr College, University of California, Carnegie Institute of Technology, Central State College, Colorado School of

New President is Congratulated

E. S. Calvert, Gulf Oil Corporation, Tulsa, (center) is congratulated upon his election as president of the Oklahoma Petroleum Council for 1961 and 1962 by S. D. Breitweiser, DX Sunray Oil Company, Tulsa, whom Calvert succeeds as president. At right is F. C. Fellingham, Pan American Petroleum Corporation, Oklahoma City, elevated by the Council to the position of executive vice president after serving a two-year term as vice president. James O. Kemm, not pictured, OPC executive manager, Tulsa, was re-elected secretary-treasurer.

NOW MADE IN ENGLAND

by Rob't. Cort & Son, Ltd.

MAINTENANT FABRIQUÉ EN FRANCE

par Grove France S.A.

ORA FABBRICATA IN ITALIA

da Nuovo Pignone

GROVE G-4 SEAL "O" RING® GATE VALVES

are now being manufactured in England, Italy and France to assure availability of these proven pipeline valves throughout the world. Grove G-4 Gate Valves feature proven double-action sealing: a primary metal-to-metal seal backed up by protected o-rings to assure a positive bubble-tight closure. Another major advantage—Grove G-4 Valves never need lubrication. Dependability has made Grove G-4 the most popular "Big" Gate Valve in use today. Please address inquiries for technical data to Grove France S. A.

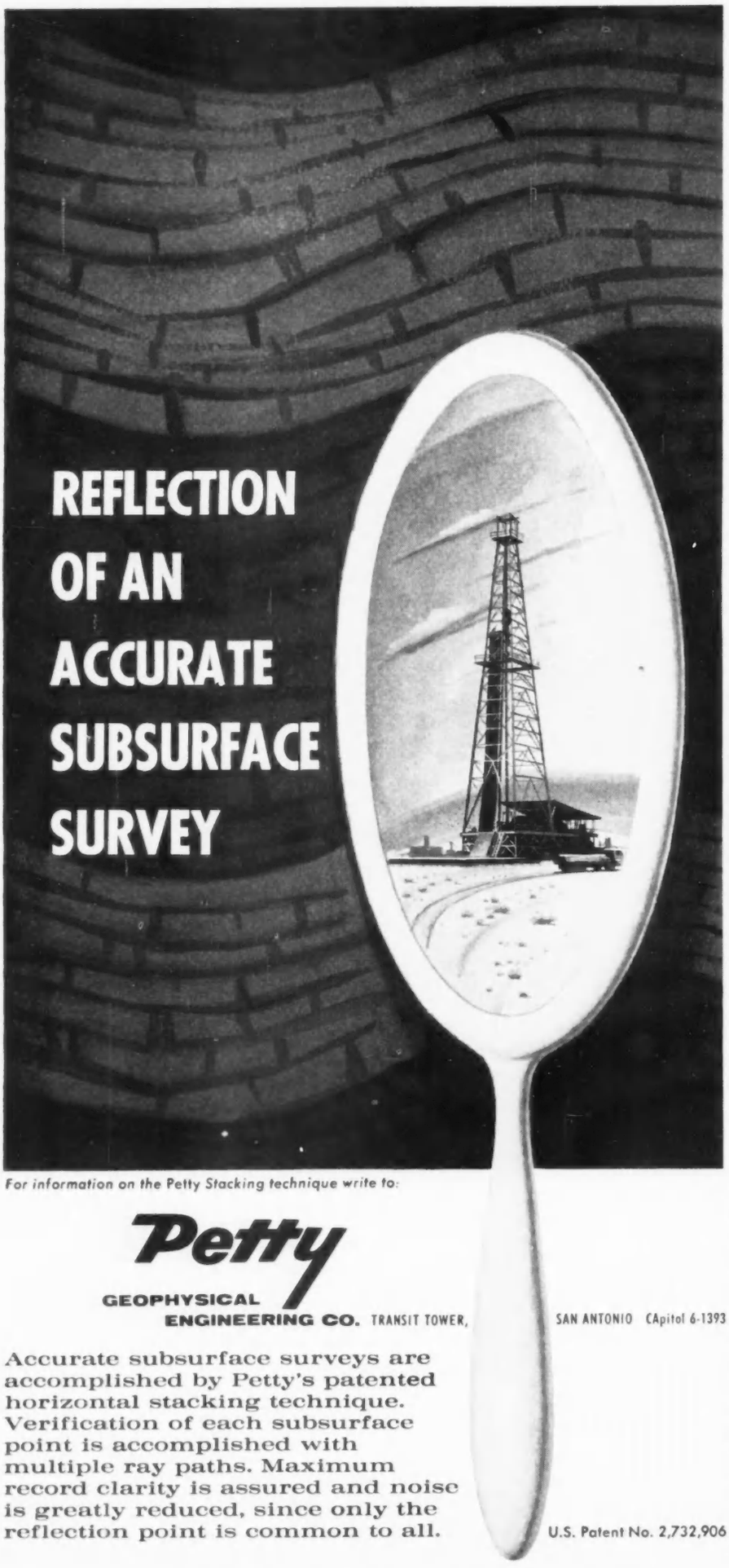
GROVE PIPELINE VALVES

GROVE VALVE AND REGULATOR COMPANY

Oakland 8, California — a subsidiary of Walworth

Subsidiary: Grove France S. A., 24 Avenue de la Grand-Armée, Paris 17e
Western Continental European Sales Representative, except Italy: Pétrochimie, 77 Rue la Boétie, Paris 8e

Licensees: Nuovo Pignone, Casella Postale 487, Firenze, Italy
Robert Cort & Son, Ltd., Reading, England



For information on the Petty Stacking technique write to:

Petty
GEOPHYSICAL ENGINEERING CO. TRANSIT TOWER, SAN ANTONIO CApitol 6-1393

Accurate subsurface surveys are accomplished by Petty's patented horizontal stacking technique. Verification of each subsurface point is accomplished with multiple ray paths. Maximum record clarity is assured and noise is greatly reduced, since only the reflection point is common to all.

U.S. Patent No. 2,732,906

Your industry at work

Mines, Cornell University, University of Denver, Eastern Michigan University, Fresno City College, Georgia Institute of Technology, New York University, Northwestern University, University of Notre Dame, Oklahoma City University, Oklahoma State University, University of Oklahoma, Pennsylvania Military College, Pennsylvania State University, University of Pennsylvania, Purdue University, University of Houston, Indiana University, Jackson Junior College, Kansas State University, Louisiana State University, Massachusetts Institute of Technology, Merrimack College, University of Michigan, University of Missouri School of Mines & Metallurgy, Rensselaer Polytechnic Institute, University of Southwestern Louisiana, Stanford University, Syracuse University, Texas College of Arts & Industries, Texas Technological College, University of Tulsa, Vassar College, Yale University, Ballet Theatre School and Julliard School of Music.

Socony Mobil Oil Forms New Operating Division

Socony Mobil Oil Company, Inc., has announced it will form a new operating division, Mobil Petroleum Company, which will be responsible for its business interest in the Far East, Australia, Eastern and Southern Africa.

A. V. Danner

Arthur V. Danner will be president of Mobil Petroleum. Danner, a director of Socony Mobil, will also be proposed for election as an executive vice president of Socony Mobil. He is now a senior vice president in charge of research and engineering.

The action results from an agreement under which the assets of Standard-Vacuum Oil Company, of which Socony Mobil Oil Company is 50-percent owner, will be divided between Socony Mobil and the other owner, Standard Oil Company (New Jersey). Preparatory steps for the division of Standard-Vacuum's assets will begin immediately. Standard-Vacuum and its affiliates will continue without interruption all activities in which they are now engaged. Only the ownerships of various Standard-Vacuum affiliates and branches are affected.

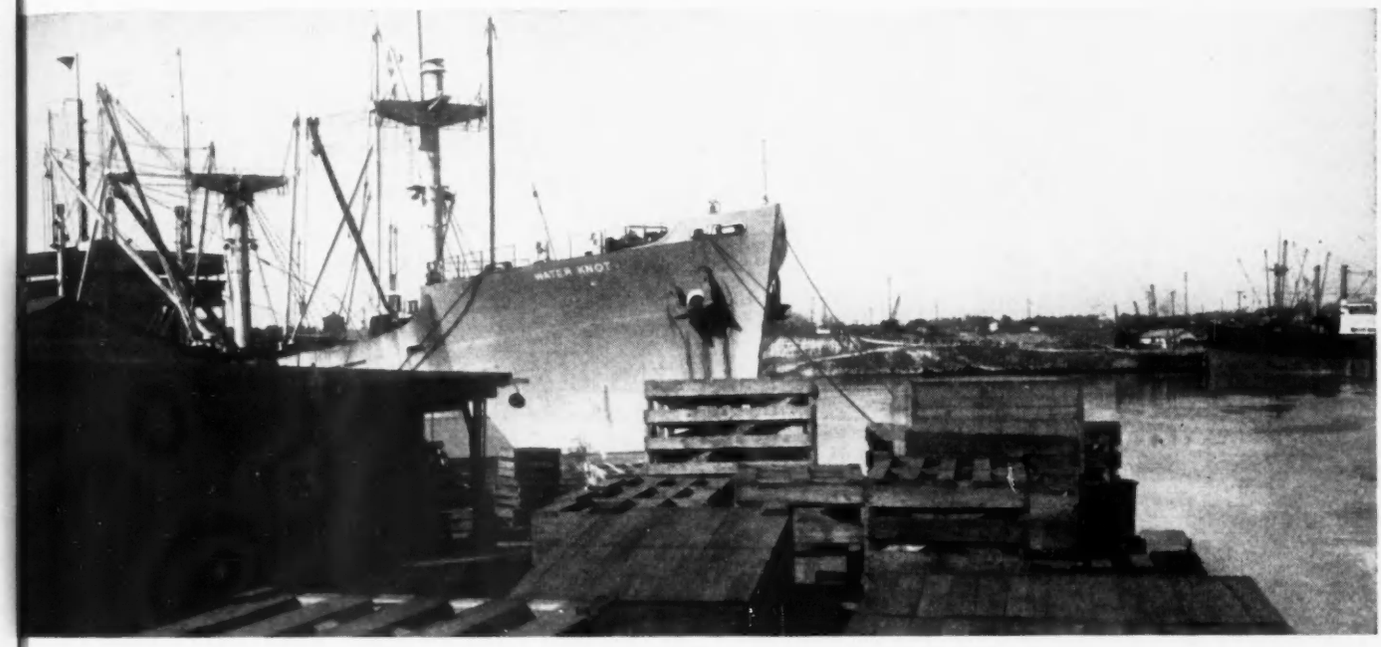
Texstar Petroleum Gains Interest in Kansas Field

The Texstar Petroleum Company, oil and gas division of the Texstar Corporation, has acquired the full working interest in approximately 7,500 acres of proven, gas-productive leases in Marion County, Kansas, from the Can-Am Petroleum Co. of Wichita, Kan., and others.

Announcement of the acquisition was made jointly by Dr. Robert V. West, Jr.,

SUPPLIES FOR THE
PETROLEUM INDUSTRY

small orders . . . large orders



receive fast service
from
WILSON SUPPLY
INTERNATIONAL

Maintenance supplies or a drilling rig, whether the order is large or small, your Wilson Supply International representative will see to it you get **what** you want . . . **when** you want it. That's been the byword of Wilson Supply operations for 39 years.

Write for the list of suppliers Wilson Supply International represents, and for **fast,** dependable service, contact your Wilson Supply representative, or write: Wilson Supply International, P.O. Drawer 19, Houston.

Drilling Machinery • Packaged Compressors • Tubular Goods • Fishing Tools • Production Equipment • Oil and Gas Supplies • Pipe Lines • Refineries

1301 CONTI ST., HOUSTON, TEXAS • 9 ROCKEFELLER PLAZA, NEW YORK, N.Y.

WILSON SUPPLY
INTERNATIONAL
DIVISION

CABLE ADDRESS: WILSCO
Servicios Petroleros, S.A., Apartado 1079, Lima, Peru • Intercolombiana, Ltda., Apartado Aereo No. 48-84, Bogota Colombia • Industrial Agencies, Ltd., 14 High Street, San Fernando, Trinidad B.W.I. • Tehran Supply Company, Forsat Ave. 76 Nikpour St., Tehran, Iran • Anglo Espanola de Electricidad, S.A., Av. Jose Antonio 525, Barcelona 11, Spain • Commonwealth Diamond Tools Pty. Ltd., REDFERN, Alexandria, N.S.W., Australia • New Zealand Diamond Tools, Ltd., 22 Oruanui St., Taupo, New Zealand.

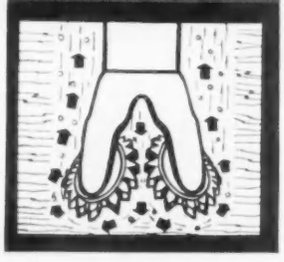
PESA

"WHAT YOU WANT – WHEN YOU WANT IT"

6006

CECA

supply a full range of mud chemicals for all conditions



Drilling Mud Chemical Supply Service

The manufacturers of CLARSOL drilling bentonites and CECABAR barytes now offer a complete range of fully proven and tested mud chemicals from leading European sources. This service for full range supply shows marked economy in procurement and ensures properly phased deliveries.

MUD

CHEMICALS

by CECA

Available in all oil producing centres

Sales Offices in all European Countries.
Warehousing services available in certain major fields.
Laboratory and Technical Facilities for specific problems.

CECA

THE BRITISH CECA CO. LTD.
175, PICCADILLY, LONDON, W.I.
Cables: ACTICARBON. LONDON
Telegrams: ACTICARBON. LONDON. TELEX

Your industry at work

president of Texstar Petroleum Co. and Harold D. Beckwith, president of Can-Am Petroleum Co. Purchase price was not disclosed.

The 7,500 acres acquired are situated in the East Antelope gas field. Gas production in the field is from Mississippian lime at a depth of approximately 2,400 feet.

The Texstar Corporation plans to immediately initiate a drilling program to fully develop the leases. Markets for the gas production are currently being negotiated.

Acquisition of the Marion County gas field was in line with Texstar's policy to acquire semi-proven, rather than wild-cat prospects with emphasis on gas; to develop and get these prospects into production.

Under the acquisition terms, Can-Am and others retained an overriding royalty which will revert to a working interest at a later date. Included in the transaction was one shut-in gas well drilled earlier by Can-Am and others.

Jade Oil Issued Permit To Negotiate With Blue Oil Co.

The Division of Corporations of the State of California has issued a permit to The Jade Oil Company to negotiate with Blue Oil Gas Company of Houston, for an exchange of Jade Oil Company stock for the oil and gas properties owned by Blue Oil Gas Company.

Blue Oil Gas interests include a participating interest in 80 producing oil and gas wells, a royalty interest in 250 oil and gas wells and a lease interest in more than 100,000 acres in Texas and Louisiana.

Texam Oil Acquires More Interests in Louisiana

Texam Oil Corporation has acquired additional working interest in three producing fields for $375,000, increasing its reserves by 325,000 barrels of oil and 2.5 billion cubic feet of gas and its oil production by 60 net barrels daily.

With these acquisitions Texam now owns a 35 percent working interest in 1,000 acres in the Skinner Lakes field, Beauregard Parish, La., with three producing wells and a shut-in gas well; a 30 percent working interest in 240 acres in the Joarcam field, Alberta, Can., with three oil wells producing from the Viking formation, and a 21 percent working interest in 480 acres in the Gilby field, Alberta, with three Viking oil wells and a 10.5 percent working interest in a Mississippian gas well soon to be connected to the Alberta Gas Trunkline system.

Three additional proven locations in the Joarcam field will be drilled in the near future, while further development is currently under way on the Skinner Lakes field property.

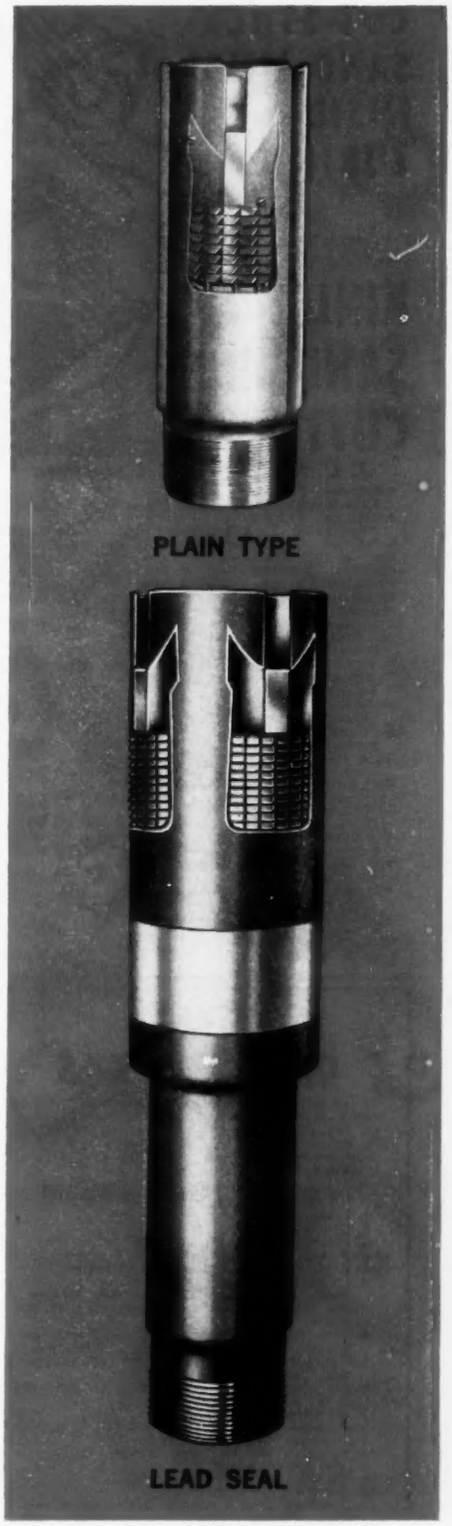
BURNS CASING HANGER

for easier circulation around the hanger and a positive seal after cementing

Burns Casing Hangers embody all the advanced features of the Burns line—one-piece streamlined body with the slips contained in separate machined recesses in the body. The entire area of each slip is completely supported by the strength of the hanger itself throughout the full length of the slip travel. This eliminates broken slips and allows positive grip action.

Each slip acts independently of the other in Burns Casing Hangers, so that the load is evenly distributed by the entire area of all the slips. Positive action is assured by the provision of three springs to raise each slip. Slips are free to release as the load is removed and will act as a reliable casing catcher when retrieving the liner. Circulating grooves can be milled in the body between the slips for cementing. Circulating grooves reduce the velocity around the hanger assuring a better cement job. Cementing the well can be done either before or after the hanger is released.

Burns Casing Hangers can be set properly even though the oil string is frozen by rotating the running in string six turns to the right which allows the slips to raise against the water string and by taking a stretch on the frozen oil string. Hanger is set and casing suspended properly. Burns casing hangers do not depend on drag spring friction action to set the slips.



PLAIN TYPE

LEAD SEAL

BURNS PLAIN TYPE CASING HANGER

Simplified, streamlined, one-piece body... used where support is needed for the oil string and where pressure seal is not required.

BURNS LEAD SEAL CASING HANGER

Only hanger manufactured with sealing element located below the slips. No danger of broken lead jamming the slips when retrieving the oil string.

Write today for complete product catalog

BURNS TOOL COMPANY

Sold through leading supply houses

8346 Salt Lake Avenue, Bell, California LUdlow 2-6209

Branch office:
217 Walker Road
Farmington, New Mexico

Field service points:
Bakersfield, Taft, Coalinga,
Ventura, Santa Maria, Casper

IN VENEZUELA
SHARP DE VENEZUELA • CARRETERA G—TIA JUANA • EDO ZULIA—VENEZUELA

CUT STUCK SAND LINES INSIDE TUBING

KINLEY SAND LINE CUTTER

J. C. KINLEY CO., Licensees

ABILENE, TEXAS
Eads Engineering Services, Inc. ..... OR 2-8655
ABILENE, TEXAS
Dunnam Service & Equipment Co. ..... CR 2-5331
ABILENE, TEXAS—Hudson-Eads, Inc. ... OR 2-5331
BAY CITY, TEXAS—J. P. Graham ..... CI 5-4526
CASPER, WYOMING—C. A. White 3-5264
FULLERTON, CALIFORNIA—Dyna-Log ... LA 6-1184
GLENDIVE, MONTANA—C. A. White ... EM 5-3833
HOBBS, NEW MEXICO
Horne Well Service Co. 3-5396
KILGORE, TEXAS
Davis-Kemp Tool Co., Inc. 5541
LIBERAL, KANSAS—Rainbo Service ... Main 4-3598
LINDSAY, OKLAHOMA
Rainbo Service Co. ..... PL 6-2530
MIDLAND, TEXAS
Luccous Service & Eqpt. Co. ..... MU 2-8311
NATCHEZ, MISSISSIPI
Davis-Kemp Tool Co., Inc. 2-3021
NEW IBERIA, LOUISIANA
Klein-Deco Wire Line Service ..... EM 9-6632
OKLAHOMA CITY, OKLAHOMA
Rainbo Service Co. ..... ME 4-2131, ME 4-0105
STERLING, COLORADO
Cable Drilling, Temp. & Well Serv. Co. .. LA 2-4761
VIDALIA, LOUISIANA
Davis-Kemp Tool Co., Inc. ..... ED 6-4224
WHITTIER, CALIFORNA
Kline Wire Line Co. ..... OX 3-2731
WICHITA FALLS, TEXAS
Eads Engineering Services, Inc. 766-0931
WICHITA FALLS, TEXAS
Hudson-Eads, Inc. 322-8584
WILLISTON, N. DAKOTA
C. A. White ..... GR 3-6555

1961
OIL DIRECTORIES

17 pocket-size, plastic-bound personnel directories covering the buying power of the entire oil industry of the world, from top executives to foremen. Over 135,000 key men are listed. First seven books cover Producing and Drilling Contracting.

We Send Our Directories on Approval

1. Texas
2. Oklahoma
3. California
4. Kansas
5. Mich.-Ill.-Ind.-Ky. and Eastern States
6. La.-Ark.-Miss.-Ga.-Fla.
7. Rocky Mountain Region and New Mexico
8. Oil Well Drilling Contractors (Covers the World)
9. Refining, Petrochemical, Construction and Natural Gas Processing Plants of the World
10. Pipe Line Companies and Pipe Line Contractors (Covers the World)
11. Oil Directory of Companies Outside the U. S. A. and Canada
12. Oil Directory of Canada
13. Directory of Geophysical and Oil Companies Who Use Geophysical Service
14. Directory of Oil Well Supply Companies (Covers the World)
15. Oil Directory of Houston, Texas
16. Oil Directory of Alaska
17. Directory of Gas Utility Companies (Covers the U. S. A.)

MIDWEST OIL REGISTER, INC.
DRAWER 7248, TULSA, OKLAHOMA
C. L. Cooper, Publisher

Join Over 26,000 Key Oil Men

Who receive WORLD OIL each month via a personal subscription. Benefit from the wealth of exploration, drilling and production ideas WORLD OIL regularly contains. See for yourself how WORLD OIL reduces the vast reaches of global oil, and its ideas, to a neat package you can hold and flip - snip, clip and file at will. Subscribe now.

Men in the industry

L. M. Cassidy

J. H. King

Leslie M. Cassidy, former chairman of the board and president of Johns-Manville Corp., and **Joseph H. King,** partner in Eastman Dillon, Union Securities & Co., have been named to the board of directors of **Olin Oil & Gas Corporation.**

Edd R. Turner has been appointed assistant Southern Division exploration manager for **Tidewater Oil Company.** Turner will work directly under Division Exploration Manager **Jed Maebius. R. W. Snyder** was elevated to division geologist from assistant division geologist. Seven district managers and their home offices were also named by Tidewater Oil Company. They were: **R. P. Grigg,** Southeast Louisiana, New Orleans; **Paul Morvant,** Southwest Louisiana, Lafayette; **J. P. O'Connor,** Texas Gulf Coast, Corpus Christi, Texas; **E. G. Young,** East Texas, Tyler; **W. P. Siard,** Oklahoma, Oklahoma City; **T. J. Pujol,** West Texas, Midland, and **J. D. Divelbiss,** Four Corners, Durango, Colo. Other division promotions saw **John L. Stoops,** named district geologist for Southeast Louisiana; **James B. Davis** named district landman for Southwest Louisiana; **J. W. Chappell** named district geologist for Oklahoma, and **Homer E. Oliver** named district geologist and **Revill M. Rogers** named district geophysicist for Four Corners.

George L. Scott, coordinator, organization planning, for the **Gulf Oil Corporation,** has been appointed manager, Employe Relations and Organization Planning for **Gulf European Company,** a Gulf subsidiary company headquartered in London.

N. E. F. Hitchcock, B.Sc., F. Inst. Pet., has been appointed laboratory manager of the **Castrol Group's** main research establishment at Hayes, Middlesex, England, in succession to the late **P. W. L. Gossling.** Hitchcock will hold that office in addition to that of group development chemist, a position he has occupied for the last nine years.

N. E. F. Hitchcock

L. T. Braun has been appointed to the position of chief geologist for the firm **Geophoto Services, Ltd.**

Thray Sithu U Ba Htay, I.S.S. has assumed charge of the office of chairman of the board of directors of the **Burma Oil Company (B.O.C.) (1954), Ltd.**

Houston NOMADS Hear World-Wide Reports

One hundred and twenty-two members and guests of the Houston Chapter of NOMADS heard informative reports of world-wide oil activity from 10 international guests at a recent meeting. Principal speaker of the evening was Carlton Speed, Houston, who described a recent extended tour of Russia. International guests present were (left to right) H. C. Pierson, Global Supply Co.; B. A. de Mediros, Fresinbra, Rio de Janeiro, Brazil; Guillermo de la Torro, Cameron Iron Works, Mexico City; John Edwards, ACF Industries, London, England, and Andre Brun, C.F.P.A., Algeria. International guests present but not pictured were: Jorge E. Malenchini, M.C.A., Buenos Aires, Argentina; Abdi Durukal, Petroleum and Mining Equipq, Geneva, Switzerland; Cliff Beasley, Reed Roller Bit Co., Maracaibo, Venezuela; Edwardo Barnetche and J. M. de la Garza, Perforadora Lainta, Mexico City.

Men in the industry

Lewell Adair has been appointed manager and also elected a vice president of **Libyan Atlantic Company,** a subsidiary of **The Atlantic Refining Company.** In his new capacity, Adair will be responsible for all operations-exploration, drilling production and governmental relations connected with Libyan's recent acquisition of 6½-million acre concession offshore Libya. He will headquarter in Tripoli.

John W. McPartland has been elected controller of the **Great Northern Oil Company.**

C. D. Owens, Jr., has been named director of personnel for **Sinclair Oil Corporation** and its subsidiaries. Owens' appointment, which is effective immediately, ties in with Sinclair's recently announced enlargement of its employe and community relations program. Owens joined Sinclair in 1949. He became manager of industrial relations for Sinclair's producing subsidiary in 1957, and for the past year been a member of Sinclair's Industrial Relations Department in New York City.

C. D. Owens, Jr.

Fred B. Korsmeyer, manager of employe relations for **Mobil Oil Company,** has become manager of the Corporate Employe Relations Department of **Socony Mobil Oil Company, Inc.** Also, **Clyde Port** will succeed Korsmeyer, and **William A. Greeley,** manager of Mobil Oil's Resale Development Department, will succeed Port as general manager of Twin Cities Marketing Division.

D. E. Killam, Jr., has been appointed manager, Land Department, for **Texas Gas Exploration Corporation.** He will supervise drilling agreements and the acquisition and maintenance of the company's oil and gas leases.

Dr. William A. Bruce has returned to the **Jersey Production Research Center** following an 18-months assignment in New York City with the Producing Economics Section of the Producing Coordination Department of **Standard Oil Company (N.J.).**

J. S. Royds, Houston, administrative vice president and general manager, Domestic Exploration Department, **Continental Oil Company,** has been appointed to the newly created position of vice president and exploration manager for the company's Foreign Exploration and Production Department, with headquarters in New York. Also, **W. O. Ham, Jr.,** Fort Worth, general manager of Conoco's Southwestern Region, has been appointed general manager of the Domestic Exploration Department, replacing Royds at Houston. **Harold R. Prescott,** Houston, assistant general manager, Foreign Exploration and Production Department, was promoted to the newly created position of assistant manager, Domestic Exploration Department. He will continue to headquarter in Houston.

Hugh M. Keeley has been named manager of **Mobil International's** Distribution Planning Programs Unit. **Charles N. Meravell** succeeds Keeley as regional assistant in New York for West African and Southwestern Europe operations.

James C. Storm has been elected president of **Tidelands Drilling Company,** wholly-owned subsidiary of **Diversa, Inc.** Storm was formerly executive vice president of Diversa, will maintain headquarters at the drilling company's offices in the Oil & Gas Building, in New Orleans.

Lawrence (Bud) Grames has been appointed chief engineer of **Belco Petroleum Corporation.** Other personnel changes announced include the appointment of **Robert E. McDonald** to succeed **Bill Johnston** as manager of the company's Big Piney office. Johnston has retired.

Ken Barnes, formerly with Shell Oil Company, recently transferred to the Public Relations Department of **Gulf Oil Corporation.** He will continue to headquarter in Houston.

James E. White, former supervisor of physics at **The Ohio Oil Company's Research Center** at Denver, has been appointed research associate on the staff of the Research Director **Dr. W. J. Yost.** White will be succeeded by **Robert B. Rice,** former senior research scientist.

Target **ECONOMY • SERVICE • SAFETY**

There's no danger of over-buying when you specify W. C. Norris Well Head Equipment, for the Norris line is a complete line . . . with a wide range of tubing and casing heads engineered to meet your actual needs. Norris heads offer you high selectivity . . . true economy . . . without sacrificing design, service or safety. You can buy with confidence when you buy Norris. Write for prices and complete literature today!

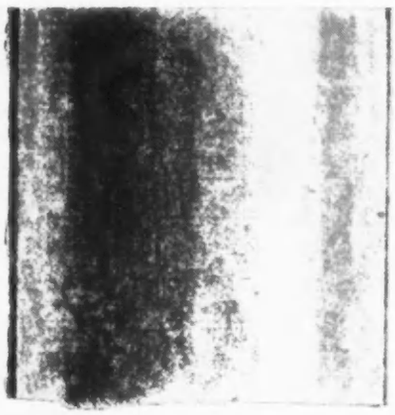
BUY FROM YOUR NORRIS DISTRIBUTOR

W. C. NORRIS DIVISION
DOVER CORPORATION
P. O. BOX 1739 • TULSA, OKLA.

NORRIS HINDERLITER WELL HEAD EQUIPMENT

BRANCHES: Great Bend, Houston, Kilgore, Odessa, Wichita Falls, Salem, Casper, Farmington

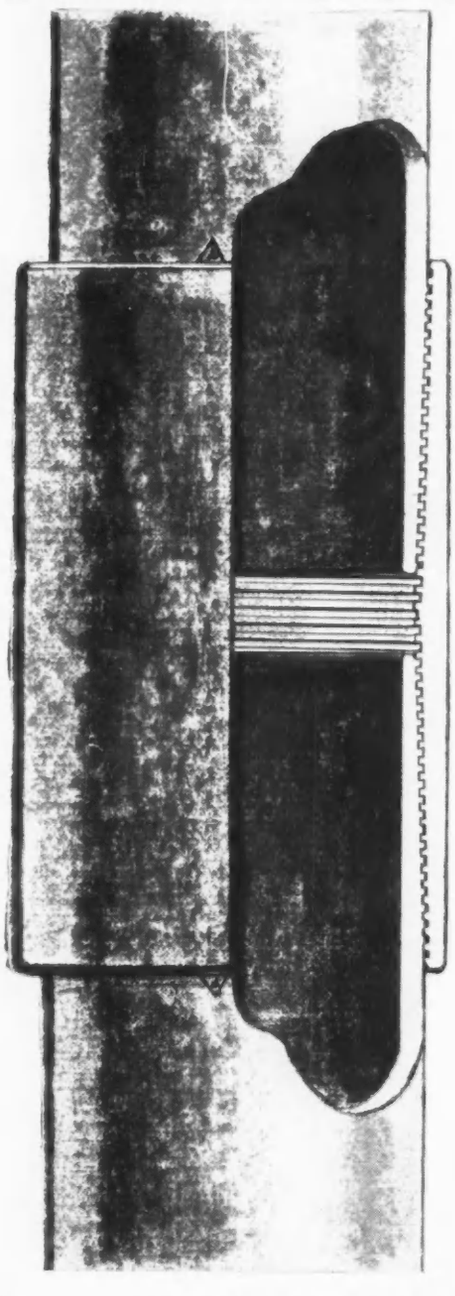
For more data on advertised products, use Readers' Service Cards, last page.



NEW!

For More Confidence In Casing Deep Wells

Pittsburgh Seamless Buttress Thread Casing



For safer, more economical completion of deep wells, you need casing with the best metallurgical qualities and strong joint design. You have it now from a new source in Pittsburgh Seamless Buttress Thread Casing.

Buttress Thread, a product of one of the country's pioneer seamless producers, will support the weight of longer casing strings. Here's why:

- Special open hearth furnace heats, made by skilled steel men with 55 years' experience, provide steel with the tremendous yield strength required.
- The small thread flank angle—three degrees—virtually eliminates hoop stress caused by tension.
- Coupling threads engage the casing threads throughout their entire length. The ¾-inch taper per foot is continuous. Fast angle vanishing threads are eliminated, so the full section of the casing supports string weight.
- Five threads per inch and the thread design promote easy stabbing and rapid spinning to reach a power-tight position.
- Inside clearance is the same throughout the string. There is no internal upset to reduce inside clearance.

For these reasons, Pittsburgh Steel Buttress Thread Casing is the best bet for your next deep well. For descriptive literature and more information, write:

Distributor Home Offices

Bennett Supply Company
Midland, Texas

Atlas Bradford Company
Houston, Texas

Buckeye Supply Company
Zanesville, Ohio

C. W. Cotton Supply Company
Tulsa 5, Oklahoma

Franklin Supply Company
Denver 10, Colorado

Houston Oil Field Material Co.
Houston, Texas

Industrial Supply Company
Wichita Falls, Texas

Iverson Supply Company
Tulsa, Oklahoma

Longhorn Supply Co., Inc.
Houston 14, Texas

Lucey Export Corporation
New York 7, New York

Lucey Products Corporation
Tulsa 19, Oklahoma

McJunkin Corporation
Charleston 22, West Virginia

Midland Supply Company
Wichita 7, Kansas

Mountain Iron & Supply Co.
Wichita 2, Kansas

The Producers Supply & Tool Co.
Fort Worth 2, Texas

Production & Refining Equipment Company
Odessa, Texas

Sandy Supply Company
Wooster, Ohio

Southwest Supply Company
Pittsburgh, Pennsylvania

The Straker Supply Company
Jackson, Michigan

Superior Iron Works & Supply Co.
Shreveport, Louisiana

Tex-Tube, Inc.
Houston 7, Texas

Western Supply Company
Tulsa 1, Oklahoma

Pittsburgh Steel Company

GRANT BUILDING • PITTSBURGH 30, PA.

Men in the industry

William P. Gee has been elected vice president and assistant to the senior vice president of **Texaco Inc.**

Nat Kogan, Cleveland, Ohio, has been elected a director of **Texas American Oil Corporation. Ralph J. Schilthuis** has been named vice president for production by **Humble Oil & Refining Company,** a new post. Schilthuis will be responsible to Humble's board of directors for coordination of all production activities.

A. F. Hamilton has been elected vice president and general manager of **Texas Gas Exploration Foreign C.A.** The company is the wholly owned foreign operations subsidiary of **Texas Gas Exploration Company,** Houston.

Dr. Leo J. Peters, formerly vice president and associate director of **Gulf Research & Development Compnay,** Gulf Oil's research subsidiary, has been promoted to the newly created office of vice president and general administrator of GR&DC. In his new position, Dr. Peters will be responsible for the day-to-day operations of the laboratory. He will report to **Dr. Blaine B. Wescott,** executive vice president of GR&DC.

Dr. L. J. Peters

W. Turner Clack, Spokane, Wash.; **John L. Kalb,** Phoenix, Ariz.; **Hugh H. Millar** and **H. R. Milner, Q.C.,** both of Edmonton, Alta., have been appointed as new directors of **Canadian Husky Oil Ltd.** They replace **George S. Buchanan; Lawrence W. Lee,** both Husky officers; **Kenneth M. Johnston** and **Paul. J. Guthrie.**

W. E. Nygren, former staff regional geologist for **Standard Oil Sompany of Texas,** has become senior staff geologist in recognition of his promotion to professional specialist status in the company.

A. Charles Pierce has been appointed to the position of section head in the Geological Research Division of **Jersey Production Research Company.**

Charles R. Pirtle has been transferred and promoted as Denver District landman in the Denver office of **Lion Oil Company, Division of Monsanto Chemical Company.**

Edward W. Midlam has been elected a vice president, general manager and a director of **Cit-Con Oil Corporation.** Cit-Con is owned by **Cities Service Company** and **Continental Oil Company.**

M. C. Hoffman, for the past five years a Chicago bank official specializing in the oil and public utilities fields, has been elected president and a director of **Alco Oil and Gas Corporation,** Denver.

SIMPLE SOLUTION FOR LEAKPROOF COUPLINGS IN TUBINGLESS COMPLETIONS*
Hardy - Griffin
GT-API
Modified Couplings
Seal For String's Life
Your savings from tubingless completions are protected by using the GT-API Modified Coupling with Teflon† seal rings. Leaks are eliminated. And, with no leaks at connections, you know that you're not faced with the possibility of an expensive squeeze job.
Whether your completion program calls for the conventional or the tubingless method, these GT-API Modified Couplings will give you leakproof joints. Where high pressure or resurgent shock may be a problem, the GT seal is particularly valuable.
HARDY-GRIFFIN ENGINEERING CORPORATION
HARDY-GRIFFIN
ENGINEERING CORPORATION
A Division of Atlas Bradford Company
Sales Office: 3600 Yoakum Blvd. • Phone: JA 6-1901 • Houston 6, Texas. Engineering and Plant: 14522 South Main St. • Phone: PA 9-9250 • Houston 35, Texas; 7707 Wallisville Road • Phone: OR 2-1701 • Houston, Texas; Odessa, Texas—Phone: EM 6-8241 • New Iberia, La.—Phone: EM 4-8666 • Oklahoma City, Okla.—Phone: CE 2-6665; Tulsa, Okla—Phone DI 3-6791.
*Also Conventional Completions
†Du Pont's Tetrafluoroethylene Resin

For more data on advertised products, use Readers' Service Cards, last page.

Men in the industry

L. S. Hadley has resigned as secretary-treasurer of **Sinclair Crude Oil** Company and has been appointed a vice president of the company in Tulsa. Other appointments include: **W. W. Hauser** appointed assistant secretary and assistant treasurer to succeed Hadley, and was elected to the board of directors. **Donald E. Winder,** former chief clerk has been named to succeed Hauser.

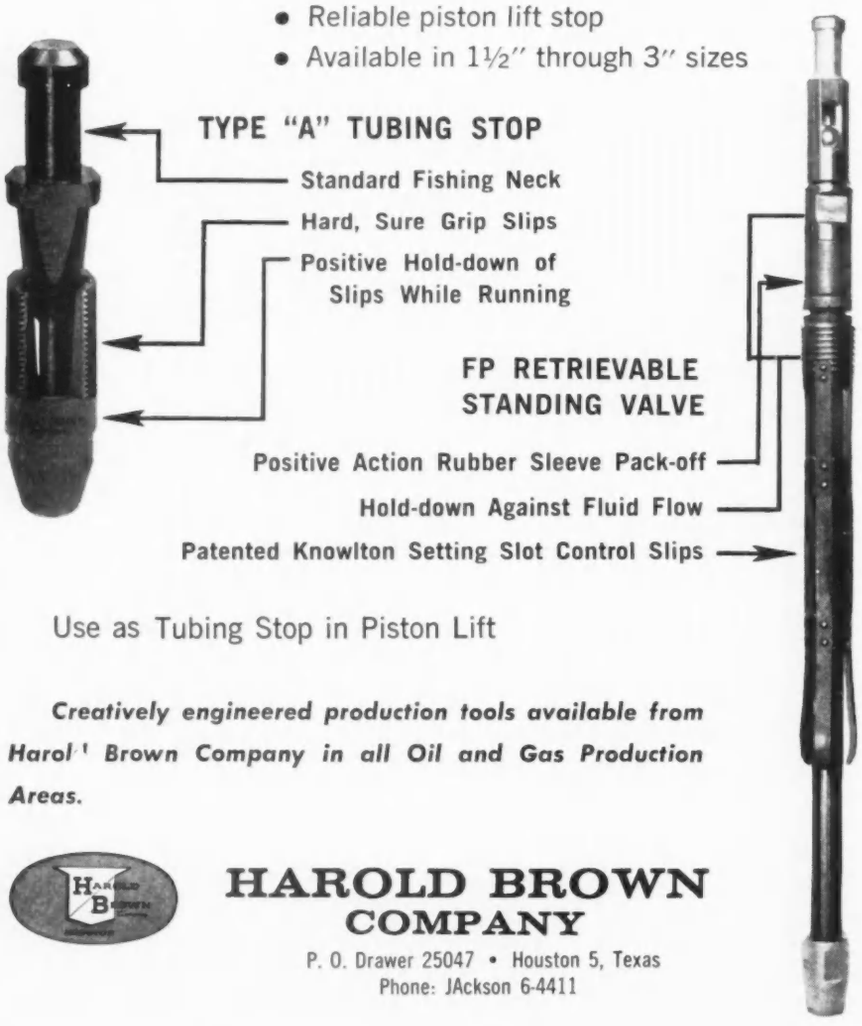
Clinton Dow Mims has been appointed assistant general manager, Producing Department, of **Standard Oil Company of California, Western Operations, Inc.** Mims was formerly vice president of **Standard Oil Company of Texas,** a Standard of California subsidiary.

Vincent R. D'Alessandro has been appointed director of industrial relations for **Sinclair Oil Corporation** and its subsidiaries.

H. J. Fitzgeorge has been appointed exploration advisor for **Mobil Oil Company** in New York. Currently district exploration superintendent for Mobil's Midland District, Fitzgeorge will report to **Fred H. Moore,** vice president of the Exploration and Producing Department.

H B **Retrievable**
TUBING STOPS and STANDING VALVES

- Simple to run
- Easy to move and reset
- Positive setting
- Useful safety tools for open-ended tubing
- Reliable piston lift stop
- Available in 1½" through 3" sizes


TYPE "A" TUBING STOP
Standard Fishing Neck
Hard, Sure Grip Slips
Positive Hold-down of Slips While Running
FP RETRIEVABLE STANDING VALVE
Positive Action Rubber Sleeve Pack-off
Hold-down Against Fluid Flow
Patented Knowlton Setting Slot Control Slips

Use as Tubing Stop in Piston Lift

Creatively engineered production tools available from Harold Brown Company in all Oil and Gas Production Areas.

HAROLD BROWN COMPANY
P. O. Drawer 25047 • Houston 5, Texas
Phone: JAckson 6-4411

WHO'S MEETING WHERE

Jan. 9–13	SAE International Congress and Exposition, Cobo Hall, Convention Center, Detroit.
17–19	ISA WINTER Instrument-Automation Conference & Exhibit, Sheraton-Jefferson Hotel and Kiel Auditorium, St. Louis, Mo.
19–20	API Committee on Public Affairs, Los Angeles Regional Conference on Employe Communications, Statler Hilton Hotel, Los Angeles
–20	Natural Gasoline Association of America, Gulf Coast Regional Meeting, The Robert Driscoll Hotel, Corpus Christi, Texas.
22–24	Kansas Oil Men's Association, Forty-Sixth Annual Convention, Broadview Hotel, Wichita, Kan.
Feb. 5–10	ASTM Committee D-2 Meeting, Benjamin Franklin Hotel, Philadelphia, Pa.
8–10	The Southwestern Legal Foundation, Twelfth Annual Institute on the Law of Oil Gas, and Taxation, Southwestern Legal Center, Dallas.
9–10	New Orleans Regional Conference on Employe Communications, Committee on Public Affairs (API), Roosevelt Hotel, New Orleans.
–16	Dallas Regional Conference on Employe Communications, Committee on Public Affairs (API), Sheraton-Dallas Hotel, Dallas.
26 to Mar. 2	AIME Annual Meeting, Penn-Sheraton Hotel, Pittsburgh, Pa.
26 to Mar 2	Society of Petroleum Engineers of AIME Annual Meeting, Chase & Park Plaza Hotels, St. Louis, Mo.
28 Thru Mar. 1	New York Regional Conference on Employe Communications, Committee on Public Affairs (API), Park-Sheraton Hotel, New York City.
Mar. – 5	Sixth Annual Gas Turbine Conference and Products Show, Shoreham Hotel, Washington, D.C.
5– 9	ASME Gas Turbine Power Conference & Exhibit, Co-Sponsored by U.S. Department of Defense, Shoreham Hotel, Washington, D.C.
8– 9	Chicago Regional Conference on Employe Communications, Committee on Public Affairs (API), Sheraton-Towers Hotel, Chicago.
8–10	API Division of Production, Southern District Meeting, Captain Shreve & Washington-Youree Hotels, Shreveport, La.
13–17	National Association of Corrosion Engineers, Annual Meeting & Corrosion Show, Hotel Statler, Buffalo, N.Y.
22–24	API Division of Production, Southwestern District Meeting, Cole Hotel, Albuquerque, N.M.
27–29	Midwest Gas Association, Annual Meeting & Convention, Sheraton-Fontenelle Hotel, Omaha, Neb.
30 Thru April 1	Fourth Symposium on Rock Mechanics, Pennsylvania State University, University Park, Pa.
April 4– 5	Gas Compressor Institute, Southwest Kansas Center, Liberal, Kan.
5– 7	API Division of Production, Mid-Continent District Meeting, The Mayo Hotel, Tulsa.
9–11	SEG, Fourteenth Annual Mid-Western Meeting, Skirvin Tower Hotel, Oklahoma City.
9–13	ASME Oil & Gas Power Conference & Exhibit, Jung Hotel, New Orleans
11–13	PESA & PIEA 1961 Conference and Exhibit, Galveston, Texas.

Nomad's Chapter monthly meeting: Los Angeles, second Wednesday, Biltmore Hotel, Wallace A. Sawdon, Secretary. Houston, second Monday, Ye Old College Inn, Elbert T. Walker, Secretary. Dallas-Fort Worth, first Monday, Greater Dallas Club, Hank Davis, Secretary. Tulsa, Totel Tulsa, Gilbert Swift, Secretary. New York, first Monday, Hotel Biltmore, Jesse E. Hickman, Secretary.

Associations

International Guests Outnumber Los Angeles NOMADS

International guests outnumbered local members at a recent Los Angeles NOMADS meeting. Left to right, front row are: Siegfried Thomas of DEA from Germany; Herbert Sweifler of Preussag, Germany; Fred Peveto of Camdrill, Libya; Jess Methe-son of Santa Fe Drilling, Africa; J. E. Bacot of Q.P.C., Trucal Coast; Guy Goldsmith of Aramco, Saudi Arabia. Middle row, Heinz Lettner of DEA, Germany; Achim W. Weide of Fagro, Germany; Fred L. Watkins of Arrow Drilling to Iraq; C. B. Welch of Santa Fe Drilling, Trinidad; Ray Conger, ex-Brown Drilling Co., Guatamala; D. S. Campbell of Santa Fe Drilling, Iran to Chile. (Back row) H. P. Downey of Arrow Drilling to Iraq; H. E. Schumacher of Camdrill, Libya; Elmer Jones of C.S.V., Venezuela; G. T. Graves of Arrow Drilling to Iraq; Nomad Connie Ridgeway of Macridge, Lebanon, and Herbit Berk of Petrobras, Brazil.

D. L. Connelly

Harold Decker

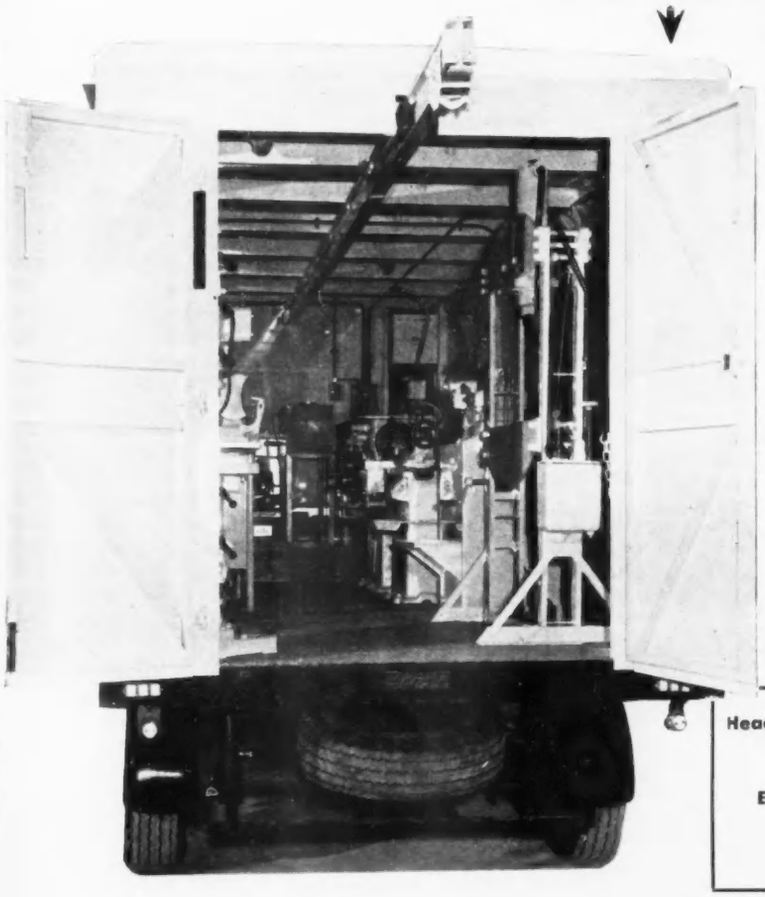
Mid-Continent Association Elects Connelly President

Donald L. Connelly, director and senior vice president of Warren Petroleum Corporation, was elected president of the Mid-Continent Oil & Gas Association at that association's annual meeting recently. Connelly succeeds W. J. Goldston, Houston oil leader. Goldston will continue as a member of an industry-wide task force that is seeking gas legislation to remove utility controls at the wellhead.

Other officers elected for 1961 are: Harold Decker, president of the Highland Oil Company, Houston, first vice president; Joe T. Dickerson of Houston and Washington, re-elected executive vice president; Clarel Mapes, Tulsa, re-elected secretary-treasurer, and Estill S. Heyser, Jr., of Dallas, was named vice president for Shreveport and was elected to the Louisiana post.

MOBILE WORKSHOPS and EXPLOSIVES TRANSPORTERS

ARE SPECIAL FEATURES OF OIL CAMP EQUIPMENT IN WHICH REALL EXCEL



REALL of ENGLAND

are

Britain's Foremost Specialists in mobile camps for all areas

REALL COACHBUILDERS LTD.

Head Office & Works: 470-474 Bath Road, Cippenham, Slough, Bucks.
Tel: BURNHAM (BUCKS) 1151 & 1152
Cablegrams: REALL, SLOUGH

Export Sales Dept. 197 High Street, Kensington, London, W8
Tel: WESTERN 0720 & 9938
Cablegrams: REALLEX LONDON
Inland Telegrams: REALLEX LONDON W8

Associations

Tulsa Geological Society Elects Andress President

Bill O. Andress, Blackwell Oil and Gas Co., has been elected president of the Tulsa Geological Society for 1960-61. Other officers elected were: A. L. Kidwell, Jersey Production Research Co., first vice president; James E. O'Brien, W. C. McBride, Inc., second vice president; James H. Moore, Schermerhorn Oil Corp., secretary; Calvin J. Butterfield, Sullivan and Leroux, treasurer, and Lyman C. Dennis, Graybol Oil Corp., editor and chairman of the publication board.

Carothers New President for Society of Well Log Analysts

J. E. Carothers, Phillips Petroleum Company, Bartlesville, Okla., has been elected president of the Society of Well Log Analysts.

Other officers elected include: Robert Sarmiento, Jersey Production Research Company, Tulsa, vice president, and William Lang, Cities Service Oil Company, Bartlesville, secretary-treasurer.

Kipp 1961 President for AIME Society of Petroleum Engineers

Earl M. Kipp, special consultant-producing problems on the staff of the vice president in charge of producing for Standard Oil Company of California, San Francisco, will be the 1961 president of the Society of Petroleum Engineers of AIME, taking office in February. Kipp will succeed 1960 President Wayne E. Glenn, production manager for Continental Oil Company.

New vice presidents for 1961 will be Milton E. Loy and L. P. Whorton. Loy is Southeast area manager for Schlumberger Well Surveying Corporation in New Orleans, and Whorton is research manager for the Research and Development Laboratories of The Atlantic Refining Company, Dallas. Vice presidents retiring will be R. A. Morse, associate director of research for Gulf Research & Development Company, Pittsburgh, and W. D. Owsley, senior vice president of Halliburton Company, Duncan, Okla.

New members of the board of directors who will begin their terms of office in February include: Robert G. Parker, regional production manager for the Central Region of Continental Oil Company, Oklahoma City; Sidney B. Richards, division engineer for the Canadian Division of Pan American Petroleum Corporation, Calgary, and Hal M. Stanier, Northern District production manager for Sunray Mid-Continent Oil Company, Bakersfield, Calif.

Lloyd E. Elkins, production research director for Pan American Petroleum Corporation, Tulsa, will become president-elect in 1961 of AIME. In 1962, he will assume the presidency.

Two other members of SPE were elected 1961 vice presidents of AIME. They are: John S. Bell, production manager of the Gulf Coast Division of the Humble Oil & Refining Company, Houston, and Wayne E. Glenn. Elected to the board of directors for a three-year term beginning was Robert B. Gilmore, senior vice president of the Dallas petroleum consulting firm of DeGolyer and MacNaughton.

Robert L. Reed Elected Director of IPAA for 1961

Robert L. Reed, president and director of Wilshire Oil Company of Texas, has been elected a director of the Independent Petroleum Association of America for 1961.

IPAA, with headquarters in Tulsa, and more than 13,000 members, is a trade association representing independent producers, refiners and distributors of crude oil, gasoline and related products. Wilshire Oil is a wholly-owned operating subsidiary of Britalta Petroleums Limited, a Canadian independent oil company with headquarters in Calgary, Alta.

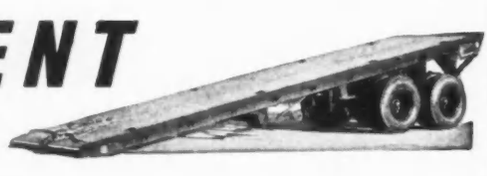
Draftsmen's Association Organized in Wyoming

The recently organized Draftsmen's Association of Casper, Wyoming, has elected as its president J. D. Griffin, supervising draftsman of Tennessee Gas and Oil Company. Serving with Griffin will be Robert L. Oberlender of Mapco, vice president; Ray Bailey, El Paso Natural Gas Products, secretary, and John Wantulok, Ohio Oil Company, treasurer.

OILFIELD TRUCK AND FLOAT

Thornycroft Sandmaster 252" wheel base Oilfield Truck. Hands-England full Oilfield Body. 60,000 lb. winch, heavy duty gin poles, winch operated gin pole risers and folding SAE king pin.
Hands-England 75,000 lb. capacity, tandem axle Oilfield Float 30' 0" long and 9' 6" wide, folding support legs and inverted 36" fifth wheel.
Truck and Float on Michelin 18.00 x 25. Sahara "X" sand tires.

OILFIELD TRANSPORTATION EQUIPMENT



OILFIELD FLOAT

Hands-England 75,000 lb. capacity tandem axle Oilfield Float 30' 0" long and 8' 6" wide, folding support legs and inverted 36" fifth wheel.
Float on 11.00 x 20 — 14-ply tires.

OILFIELD TRUCK AND FLOAT

Scammel Constructor 261" wheel base Oilfield Truck.
Hands-England 75,000 lb. capacity tandem axle Oilfield Float 30' 0" long and 9' 6" wide, folding support legs and inverted 36" fifth wheel.
Truck and Float on 14.00 x 20—18-ply tires

OILFIELD FLOAT

Hands-England 25,000 lb. capacity single axle Oilfield Float 24' 0" long and 8' 0" wide, folding support legs and SAE king pin 11.00 x 20—12-ply tires. Steel stake sides.

HANDS-ENGLAND OILFIELD EQUIPMENT LTD. Works Road, Letchworth, Herts., England.

Telephone: Letchworth 600 Telegrams: Oil, Letchworth. Cables: Oil, Letchworth, England

B.M.I

New York NOMADS Turnout

In addition to a large attendance of local guests and NOMADS, there was an unusually large turnout of out-of-town guests at a recent New York NOMADS meeting. At the meeting were, (front row): J. M. Foster, Loffland Bros. Drilling Co.; David C. Bianchi, Baker Transworld; Kenneth J. Langley, Buenos Aires, Argentina; M. S. House, Pan American International Oil Co.; D. M. Brown, Aramco, Saudi Arabia; Tom Ashe, Globe Oil Tools Co., and Leo Falcon, Petrogas, Argentina. (Second row, left to right) John F. Dinda, Creole Petroleum; R. Gaylord, Wagner Morehouse, Los Angeles; Raif Erisken, American Iron & Machine Co., Rome, Italy; R. T. Boulter, American Overseas Petroleum Ltd.; Alan Ford, Stoca, Lima, Peru; Abbas Ghaffari, National Iranian Oil Co.; Ralph Williams and Jack Gompf, Oasis Oil Co. of Libya, Inc., and Keyvan Naraghi, National Iranian Oil Co. (Third row, left to right): R. Opbroek, Bataafse Intl. Petroleum Co.; Fred B. Williams, Kellogg Overseas; Dick Myers, Caltex Service Co., and Harold F. Allen, National Iranian Oil Co.

API Honors Oilmen for Outstanding Contributions

Five oilmen from the Division of Production were honored at the Fortieth Annual Meeting of the American Petroleum Institute which was held in Chicago recently for their outstanding contributions to the oil industry.

The five certificate recipients were: John R. Evans, Standard Oil Company (Indiana), Chicago; C. E. Haven, National Bureau of Standards, Washington, D. C.; Edgar Kraus, The Atlantic Refining Company, Dallas; Mercer H. Parks, Humble Oil & Refining Company, Humble Division, Houston; M. L. Powers, The University of Oklahoma, Norman, and Walter F. Rogers, Gulf Oil Corporation, Houston.

The oilmen were presented the API "Certificate of Appreciation" for their service to the API and the industry over the years.

Oil Lifting Course Slated For Texas Tech College

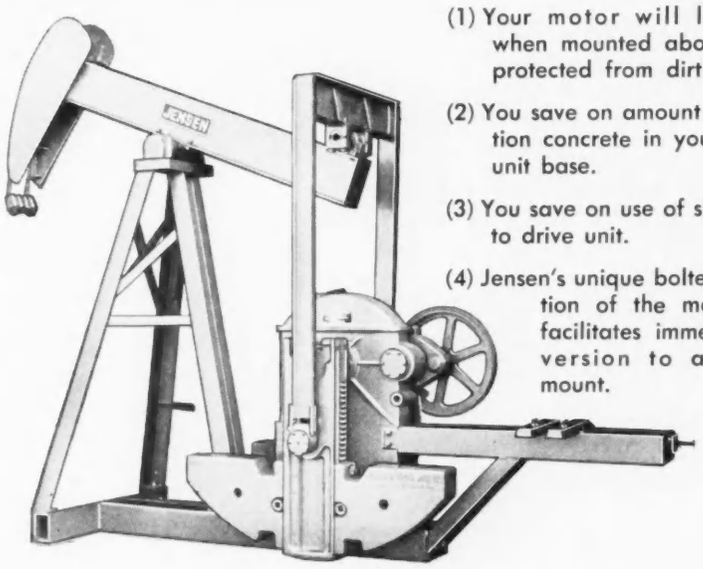
The West Texas Oil Lifting Short Course is scheduled for April 20-21 at Texas Technological College at Lubbock, Texas. E. D. (Andy) Anderson, Lone Star Production Company engineer, Dallas, is the short course program chairman.

There will be technical lectures at the eighth annual short course and discussions on nine phases of oil lifting with approximately 30 papers presented by specialists in various fields.

Papers to be presented by engineers and production men will cover such topics as artificial lift mechanics and problems, multiple zone producing methods and equipment, rod pumping—surface and subsurface corrosion, production handling (various phases), production maintenance and general topics on safety, engineering fundamentals, management and tubular goods.

THE NEW HI-COMPACT!

Save 4 ways with JENSEN'S NEW HI-COMPACT ROTARY BALANCED JACK!



(1) Your motor will last longer when mounted above ground, protected from dirt and grit.

(2) You save on amount of foundation concrete in your pumping unit base.

(3) You save on use of shorter belts to drive unit.

(4) Jensen's unique bolted construction of the motor mount facilitates immediate conversion to an engine mount.

JENSEN'S NEW HI-COMPACT ROTARY BALANCED JACK also features SELF-ALIGNING PITMAN BEARING HOUSINGS—All bearings are prelubricated and sealed at the factory for long, service-free operation.

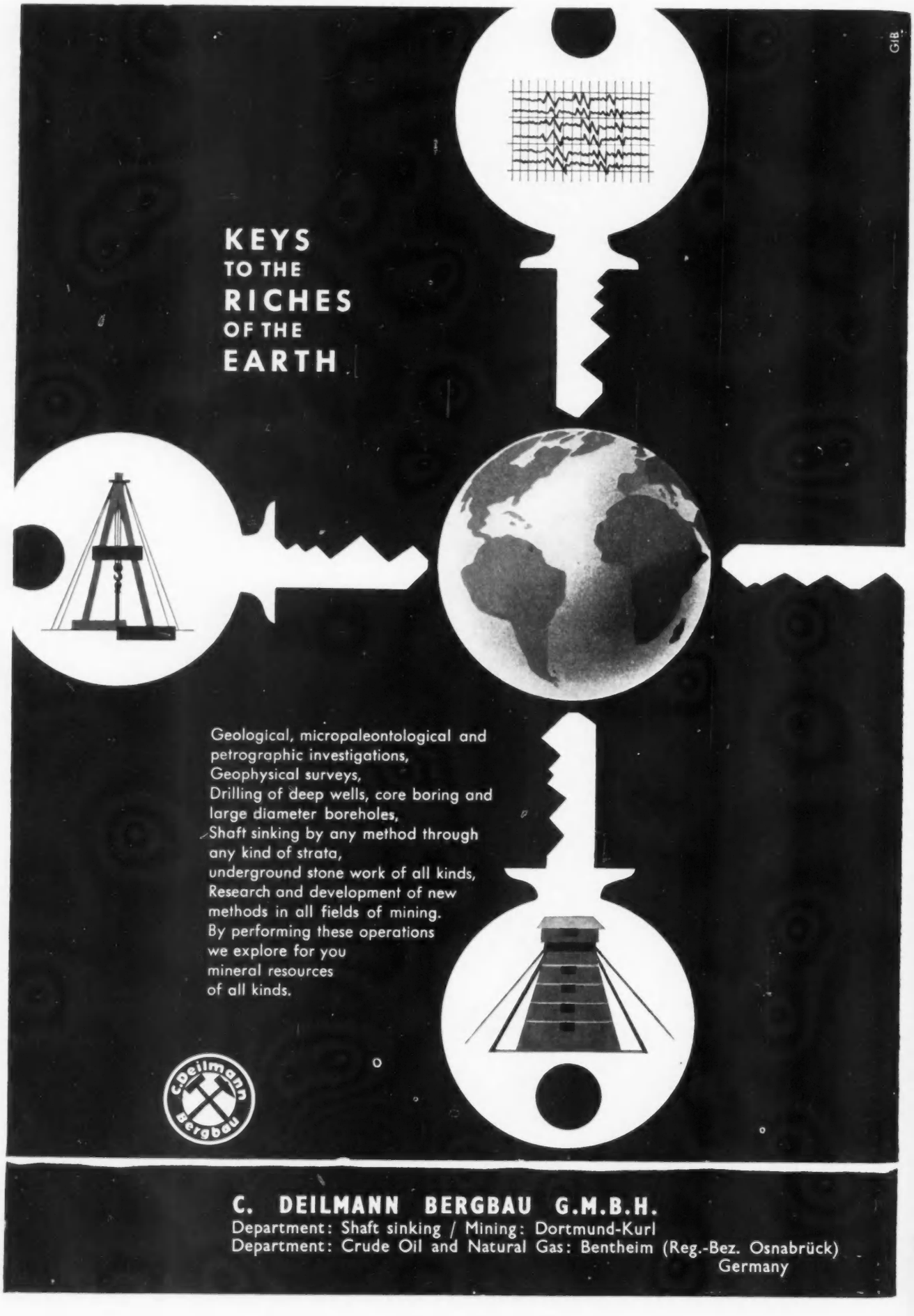
JENSEN—PACING THE PUMPING INDUSTRY SINCE 1919

Stocked by your local supply store

Made by JENSEN BROS. MFG. CO., INC. P. O. Box 477-D, Coffeyville, Kansas

Export Office: 250 Park Avenue, New York 17, N. Y.

JENSEN JACKS


KEYS
TO THE
RICHES
OF THE
EARTH
Geological, micropaleontological and
petrographic investigations,
Geophysical surveys,
Drilling of deep wells, core boring and
large diameter boreholes,
Shaft sinking by any method through
any kind of strata,
underground stone work of all kinds,
Research and development of new
methods in all fields of mining.
By performing these operations
we explore for you
mineral resources
of all kinds.
C. Deilmann Bergbau
C. DEILMANN BERGBAU G.M.B.H.
Department: Shaft sinking / Mining: Dortmund-Kurl
Department: Crude Oil and Natural Gas: Bentheim (Reg.-Bez. Osnabrück)
Germany

New Houston API Officers

The Houston Chapter of API Division of Production recently elected new officers for 1961. Those elected were, left to right: Charles E. Richards, Jr., Southwest Industries, Inc., membership; Elmer Simmons, Parkersburg Rig & Reel Co., membership; George H. Kimbrell, Reed Roller Bit Co., secretary-treasurer; E. J. Frederick, Baash-Ross Division of Joy Manufacturing Co., entertainment; B. G. Barefield, Oil Center Tool Co., entertainment; Darrell Smith, Texaco Inc., chairman; R. W. (Russ) McMurry, Hydrill Co., assistant secretary-treasurer; J. F. (Bud) Hendrickson, Phillips Petroleum Co., first vice chairman; Len Williams, Atlantic Refining Co., second vice chairman, and Frank Zimmerman, Lion Oil Co., program.

Three Groups Elect New Pacific Section Officers

Three groups, American Association of Petroleum Geologists, Society of Exploration Geophysicists and the Society of Economic Paleontologists and Mineralogists, have named new officers for each group's Pacific Section.

New officers elected for AAPG are: Irving T. Schwade, Richfield Oil Corporation, president; Richard E. Faggioli, Humble Oil & Refining Company, vice president; Robert O. Patterson, Pacific-Oil Well Logging, secretary, and Richard L. Hester, Pauley Petroleum, Inc., treasurer.

SEG elected Bart W. Sorge, United Geophysical Company, president; Marc O. Miller, Continental Oil Company, vice president—Southern District; Allen J. Garber, Jr., Texaco Inc., vice president—Northern District; Roy R. Farnsworth, Shell Oil Company, secretary-treasurer, and William O. Murphy, Jr., Standard Oil Company of California, editor.

Edwin H. Stinemeyer, Shell Oil Company was elected president of SEPM, and William J. Lewis, Standard Oil Company of California, was elected secretary-treasurer.

Louisiana Petroleum Council Re-Elects Geiger Chairman

H. J. Geiger, assistant division manager of Esso Standard Division of Humble Oil & Refining Company, was re-elected chairman of the Louisiana Petroleum Council at the annual meeting of the members held recently in New Orleans.

Selected to serve with Geiger were R. G. Renaudin, Gulf Oil, vice chairman, and Dean L. McGregor, Continental Oil Company, secretary-treasurer.

The Council also voted George Petrie, Sun Oil, Lafayette and E. W. Midlam, Cit-Con, Lake Charles to membership on the Executive Committee, governing body for the organization.

Jimmie R. Major is Director of the Council; Jack Francis is Associate Director.

RECOVER CASING FROM YOUR NEXT DRY HOLE
by using
ken-pak

Ken's oil base gel packs around casing, protects against corrosion better than cement and permits maximum casing recovery. Proved in hundreds of wells throughout the world.

"Mon! Ye'll save steel when ye ken aboot KEN!"

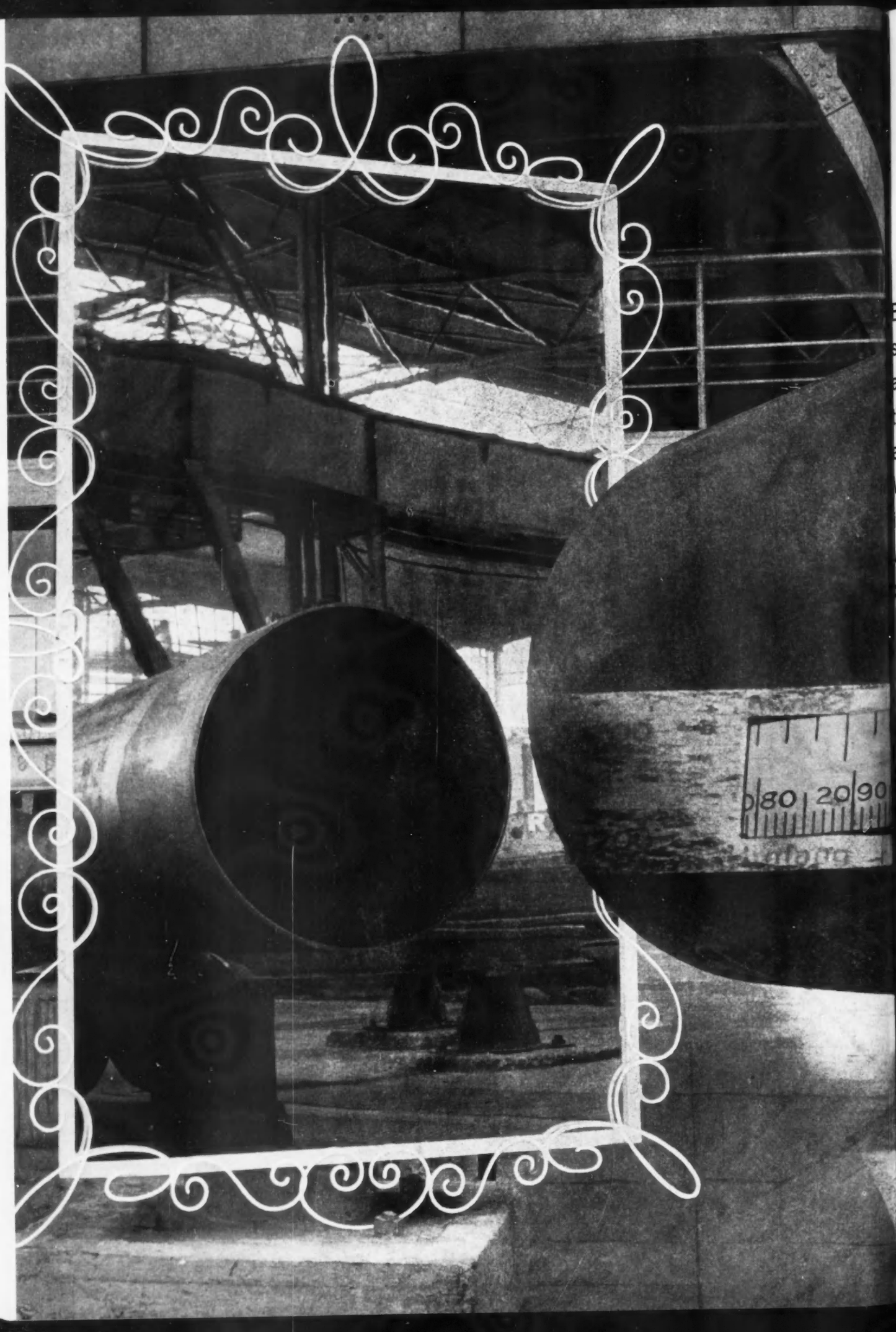
Contact your nearest Ken distributor, or

ken CORPORATION

KEN CORPORATION
2499 Cerritos Ave., Long Beach 6, California
Phone: GA. 644-28
WORLD'S LEADER IN OIL BASE MUDS

SUBSIDIARY: KENEX, INC., LONG BEACH, CALIFORNIA
BRANCH OFFICES: BAKERSFIELD, CALIFORNIA • VENTURA, CALIFORNIA • MIDLAND, TEXAS
CORPUS CHRISTI, TEXAS • LAFAYETTE, LOUISIANA • CASPER, WYOMING
DOMESTIC DISTIBUTORS: ALAMO LUMBER CO., SAN ANTONIO, TEXAS
KEN-TEX SPECIALTIES, INC., MIDLAND, TEXAS • MAY BROTHERS, INC.,
EUNICE, LOUISIANA • UNITED ENGINEERING CO., CASPER, WYOMING
AFFILIATED COMPANIES: KEN INTERNATIONAL, PARIS, FRANCE • KEN SOUTH AMERICA,
ANACO AND MARACAIBO, VENEZUELA AND BOGOTA, COLOMBIA
FOREIGN DISTRIBUTORS: JAMES BAYLISS, BRISBANE, AUSTRALIA
FAGRO, HANNOVER, GERMANY AND VIENNA, AUSTRIA • CARLO FERRARI, FLORENCE, ITALY
FORAFLUID, PARIS, FRANCE • BOSWELL INTERNATIONAL, INC., TOKYO, JAPAN
MACRIDGE, BIERUT, LEBANON, AND TRIPOLI, LIBYA • BOJORQUEZ, MEXICO, D.F.
DRILLING FLUID SERVICE, LTD., CALGARY, ALBERTA, CANADA
See Ken's Section In Composite Catalog for Other Products

For more data on advertised products, use Readers' Service Cards, last page.


80
20
90

All's well that ends well

Both ends of any length of Mannesmann-Hoesch line-pipe are so meticulously sized that they seem to be mirror images of each other – even perfectionists among you pipeliners will be pleased. From the selection of the steel all the way through to the final rugged tests Mannesmann-Hoesch is guided by the fact that a pipeline can be laid only as fast as it can be welded.

With our advanced production technology and sensitive measuring methods, it is virtually impossible for any length of Mannesmann-Hoesch pipe to leave the works unless inside and outside diameter, wall thickness, bevel, and true circular cross section are accurate to the highest possible degree.

Truly round pipe
means faster welding in the field

Grossrohrwerk Mannesmann-Hoesch GmbH

produces line-pipe from 6⅝" through 42" according to API 5 LX and other applicable standard specifications.

For detailed information, please write:

MANNESMANN-EXPORT · DÜSSELDORF · GERMANY 1376/1e

Suppliers' notes

Louis G. Montre has been named chief engineer by **Cardwell Manufacturing, Inc.** In this capacity, Montre will head the Research and Development Department and the Product Design Department, coordinating modern oil field equipment trends into new, economical operating units.

James H. Sells has been named district manager in the Houston area for **Rockwell Manufacturing Company's** Meter & Valve Division.

Bob Altenreid has joined **Chris Well Servicing Company, Ltd.,** and affiliated companies.

Loring S. Brock has been appointed president of **United States Steel** Products Division. Brock succeeds **John Hauerwaas** who has retired.

Louis J. Wernert has been appointed sales representative at Odessa, Texas, by **Pipe Inspectors Division of Plastic Applicators, Inc.**

W. F. (Bill) Krause, Jr., recently joined **MACCO Oil Tool Company, Inc.,** as chief petroleum engineer. He will act as liaison between the Sales Division and the Engineering Department of MACCO.

T. L. (Dick) Lewis has been appointed by the **Hunt Tool Company** as special representative for the Gulf Coast Division.

Jim Pace

J. R. Birdsong

J. I. Jordon has been promoted to safety manager for both field and shop operations for **Halliburton Company.** He replaces the retired **Harry Ziegler.** Other promotions from Halliburton include: **Jim Pace,** former regional safety supervisor in the field, he has assumed duties as shop safety supervisor in Duncan, Okla., and **John R. Birdsong,** formerly of the Personnel Relations Department, he has been named to replace Pace in the field.

J. I. Jordon

John L. Buster and **C. F. McMahan** have been promoted to new positions of responsibility in the Fort Worth offices of **BJ Service, Inc.** Buster, formerly Long Beach, Calif., Division engineer, moves to Fort Worth to become technical assistant to the vice president. McMahan moves from Denver, where he has been sales manager for the area, to become assistant to the sales manager at Fort Worth.

L. G. Bettis, formerly credit manager, **Bethlehem Steel Company Supply Division,** has been appointed treasurer, succeeding **Christian Seger** who resigned.

Eddie W. Harvey, formerly special pipe representative, **Continental-Emsco Company,** has been promoted to industrial sales representative and will be located in New Orleans. Also, **Ralph Hayes,** formerly galvanizing sales representative, has been promoted to industrial sales representative too, and will be located in Houston.

E. P. Boynton has been elected a vice president of **Pan Geo Atlas Corporation.** PGAC is a subsidiary of the **Chemetron Corporation.** Boynton was previously in charge of Chemetron's Patent Department and as assistant to **Charles J. Haines,** chairman and chief executive officer, at the Chicago headquarters. Boynton will share administrative duties in Houston with **Paul Charrin,** president of PGAC, and **J. H. Castel,** executive vice president.

E. P. Boynton

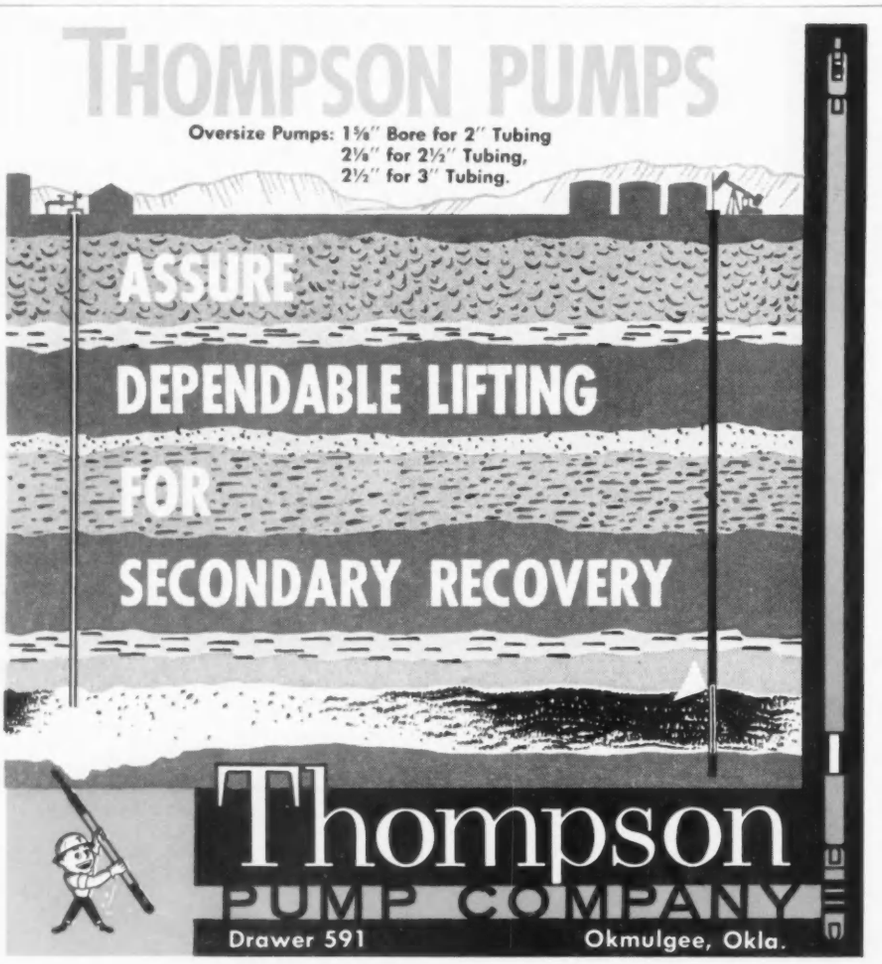
Frank J. Nunlist has been appointed to the new position of vice president-operations of **Worthington Corporation.** In his new position, Nunlist, formerly a group vice president of Worthington, will be responsible for the activities of all the company's 16 domestic operating divisions in 10 states and regional engineering and service activities. He will report to **Walther H. Feldmann,** president.

R. B. Hazard, vice president and sales manager Rubber Packing, **Raybestos-Manhattan, Inc.,** has been elected director of the Corporation.

Lou C. Michie has joined the **White Diesel Engine Division, The White Motor Company,** as sales representative covering the St. Louis and Chicago areas.

George King has been named assistant plant manager for **Tubular Lining Corporation.** Also, **Dale Miller** was appointed product engineer for the firm.

C. A. Rosenthal, former Southern Rocky Mountain Division manager at Denver for **Schlumberger Well Surveying Corporation,** has been reassigned to Houston and named Texas Gulf Coast division manager. **I. L. Roberts,** formerly Texas Gulf Coast division manager, has been transferred to Lafayette, La., as manager



"Bank of the Southwest made it easy for us to create a long range employee pension plan. First step is their free survey: Employee Profit Sharing Studies."

Bank of the Southwest
NATIONAL ASSOCIATION, HOUSTON
Member F. D. I. C.

Our new folder, "Employee Profit Sharing Studies", gives full facts on how to get started on pension and profit sharing activities. Write our Trust Department for your free copy.

Suppliers' notes

of the Louisiana Gulf Coast Division. He succeeds **W. J. Bowen** who has joined the Schlumberger overseas organization. **Adam Perez** has been promoted from sales manager of the Louisiana Gulf Coast Division to Southern Rocky Mountain Division manager.

T. L. (Tom) Parrish has been appointed service representative in the Houston area by **Hunt Tool Company.**

William G. Clark, former D+B specialist, has assumed new duties as store manager of **Continental-Emsco Company's** Rangely, Colo., store. Also, promoted to store manager at Hadacol Corners, Texas, was **Albert N. Taylor,** former D+B specialist. **Carrol L. Gillit** and **Eugene M. Peoples,** both store managers, have been transferred, Gillit, from Hadacol Corners to Andrews, Texas, and Peoples, from Andrews to Houston. **Gerald L. Huddleston,** former field salesman, is now D+B specialist at Andrews. **Issac H. Abercrombie** has been promoted from field salesman to D+B specialist at Laurel, Miss. **Walter C. Crow** has been promoted from district production machinery specialist to division sucker rod specialist at Midland, Texas. **G. G. Stegall** has moved from district sales engineer to district D+B specialist at Amarillo, Texas.

Austin T. Jones, assistant to the sales manager at Fort Worth for **BJ Service, Inc.,** has been transferred to Wichita, Kan.

W. R. Bohannan

J. O. Fighter

John O. Fighter has been appointed to the International Division office of **The Cooper-Bessemer Corporation.** The office is located in New York City. **W. R. Bohannan** has been named to succeed Fighter as branch manager of the Anaco, Venezuela, office. Bohannan was formerly a sales engineer at the Corporation's Caracas branch office.

John H. James has been elected to the office of president of **Liberty Manufacturing Company of Texas,** and **W. R. Pardue** to the office of secretary-treasurer. James, who joined Liberty in 1951 and was secretary-treasurer prior to his recent appointment, replaces **W. A. E. Woods,** who has retired.

Alexander Valchuk has been appointed managing director of Byron Jackson Company's manufacturing plant in the Netherlands. Valchuk succeeds **Earl M. Rees.** The organization was opened in 1959 and is known as **Byron Jackson N.V.**

Edward J. (Eddie) Murski has been appointed district manager of a newly opened office in Victoria, Texas, by **Associated Engineering & Equipment Company, Inc.** Home office in Houston. Murski will supervise general wire line services and reservoir testing for Associated in all areas South and West of the Colorado River in South Texas.

E. J. Murski

M. D. Hartsell, previously resident salesman at Jackson, Miss., **Jones & Laughlin Supply Division,** has been appointed district sales manager at Wichita, Kan. **C. E. Rogers** is J&L's district sales manager for South Louisiana District. The district office has been moved from New Orleans to Lafayette; **R. A. Mercer,** formerly city sales manager at Los Angeles, is now assigned as city sales manager at New Orleans. **J. A. Carrigan,** formerly district sales manager at Wichita, Kan.,

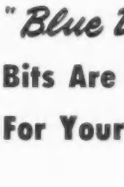
Do all bits look alike to you?

Here's Why

"Blue Demon"

Bits Are Better

For Your Budget...



"Blue Demon" Bits . . . the original replaceable blade bits developed to cut cost-per-foot in shot hole drilling . . . continue to pace bit progress as drilling conditions change.

The addition of cuttings deflectors to the face of Hawthorne's patented replaceable blades . . . to substantially reduce plugging between formation layers . . . gives the driller considerable versatility with drilling weights . . . which in turn results in faster hole . . .

Plus the 4-Blade feature developed for faster penetration in harder formations . . . with more cutting surface on bottom to keep the bit from walking . . . providing a straighter hole to load, and less strain on your drill . . .

Plus the highest quality of materials and craftsmanship in every Hawthorne "Blue Demon" product

Plus ample stocks of popular shot hole sizes maintained in every active exploration area . . .

. . . are reasons why more shot hole drillers use "Blue Demons" than all other drag-type bits combined. Try a set on your next hard-rock location.

WRITE FOR ILLUSTRATED CATALOG

HJ®

U.S. Patent Nos. 2,615,684 2,666,622 2,695,158 2,783,973 2,831,657 2,859,942 2,890,020 2,894,726

HERB J. HAWTHORNE INC.

Cable Address: HAWBIT • P. O. Box 7366 • Houston 8, Texas

298

Suppliers' notes

is now assigned as city sales manager at Los Angeles, and **J. A. Beaird,** previously district sales manager, Great Bend, Kan., is now assigned as district sales manager at Bartlesville, Okla.

George E. Doty, formerly vice president-sales, has been elevated to vice president and general sales manager for **Grove Valve and Regulator Company. B. J. Hancock,** formerly eastern regional sales manager, has been named vice president-sales and will be responsible for all field sales. **E. C. (Early) Bird** has been appointed a district sales manager in Houston and will handle sales of production valves in that region.

J. A. Tucker has been appointed chief engineer-LACT and Processing Equipment for **Jones & Laughlin Supply Division.** Tucker will administer the sale of **Major Engineering Company's** Meter Automatic Custody Transfer Units, which Jones & Laughlin was recently named distributor for Tucker will also administer the sale of tanks and related lease processing equipment.

J. A. Tucker

DeWitt T. Dees has rejoined **Baash-Ross Division of Joy Manufacturing Company** as the district sales representative in Shreveport, La.

Samuel C. Welker has been appointed resident manager and sales manager of **Black, Sivalls & Bryson, Inc's.** newly formed Swiss subsidiary, **Black, Sivalls & Bryson, S.A.** Welker will be responsible for sales of oil field and control equipment in Central and Southern Europe, North Africa and the Near and Middle East, with offices in Zug, Switzerland.

Frank L. Williams has been appointed vice president and sales manager of **Waukesha Sales & Service, Inc.** Williams has been with Waukesha for 14 years.

B. F. Krause

Frank L. Williams

B. F. (Fritz) Krause recently joined **McMurry Oil Tool Specialties, Inc.,** as special representative. He has been in gas lift equipment engineering and sales since 1937.

Earl M. Fetzer, managing director of **Continental-Emsco Company, Limited,** has been attending a management program at the University of Pittsburgh's School of Business Administration.

Rust-Oleum Corporation Opens New Holland Plant

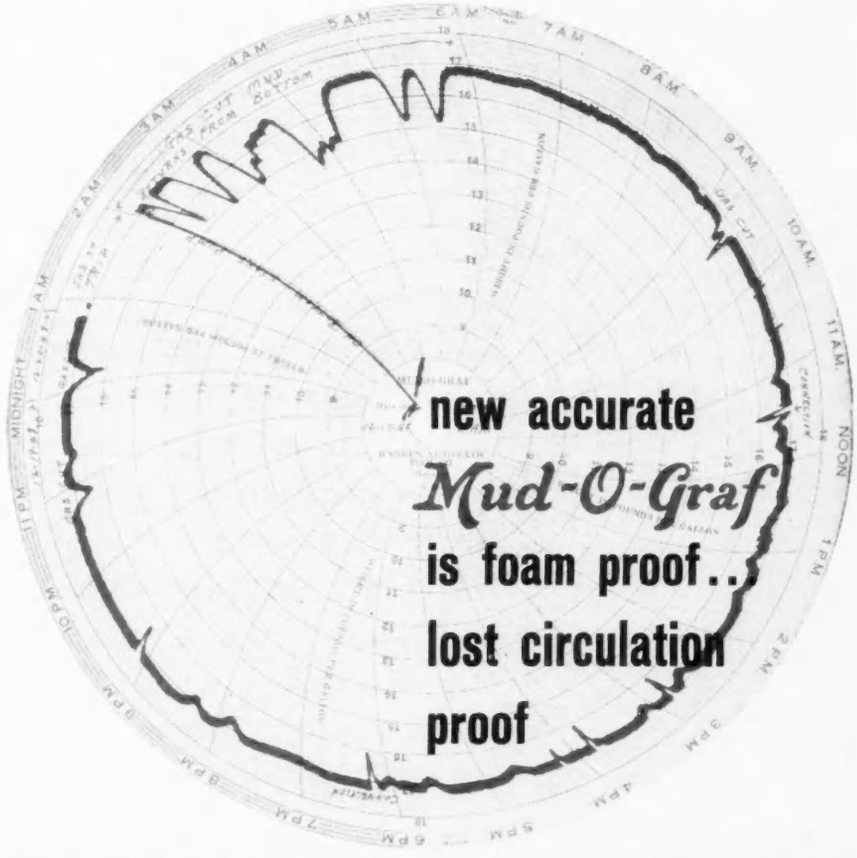
Rust-Oleum Corporation recently opened its new manufacturing plant in Haarlem, Holland, which was attended by over 300 guests, including 16 marketing executives from the Rust-Oleum plant in Evanston, Ill.

The new 30,000 square foot plant, with a capacity of 2,000 gallons per day will supply Rust-Oleum rust preventive coatings to some 25 countries.

Lane-Wells Company Opens Three New Branch Offices

Lane-Wells Company, a Division of Dresser Industries, Inc., recently announced the opening of three new offices in Woodland, Calif.; Perry, Okla., and Ruston, La.

The technical field service locations will offer all the company's newest developments in electrical logging, nuclear logging, perforating, Vibro-Frac, packers and bridging plugs. R. H. Gerecke will be field service engineer-in-charge, and D. W. Ford will be field service engineer-in-charge at the Louisiana location. The Oklahoma location is a district office. James Pickett is district manager.



More than 1 million tons of mud have been weighed by Mud-O-Graf. This experience has led to the new, foam-proof, lost circulation-proof model.

A complete cycle of weighing is made every 45 seconds. The weighed sample is completely flushed out and passes over the shaker before the next fresh sample is taken.

The recorder can now be installed on the derrick floor without adverse effects from rig vibration on either its remarkable accuracy or its general operation.

Twenty years of experience in the mud weighing business has proved that there is no substitute for a completely accurate, continuous chart record of mud weight *placed in front of the driller.* Check these features:

- A weighing unit that will handle lost circulation material or foamy mud.
- The sample is taken every 45 seconds directly from the mud stream and is not dependent on pumping to a remote location.
- Each sample is completely flushed.
- The weighing unit is smaller and easier to maintain.
- Continuous recording on a circular chart, where a full twenty-four hours is visible to the driller.
- Recording is easily readable and accurate to 1/2 of 1/10 pound per gallon.

WARREN AUTOMATIC TOOL CO.
3915 THARP STREET • HOUSTON, TEXAS
Phone CApitol 4-2511

Lake Charles HEmlock 6-2265 | New Iberia EMerson 9-9862 | Harvey FOrest 6-1441

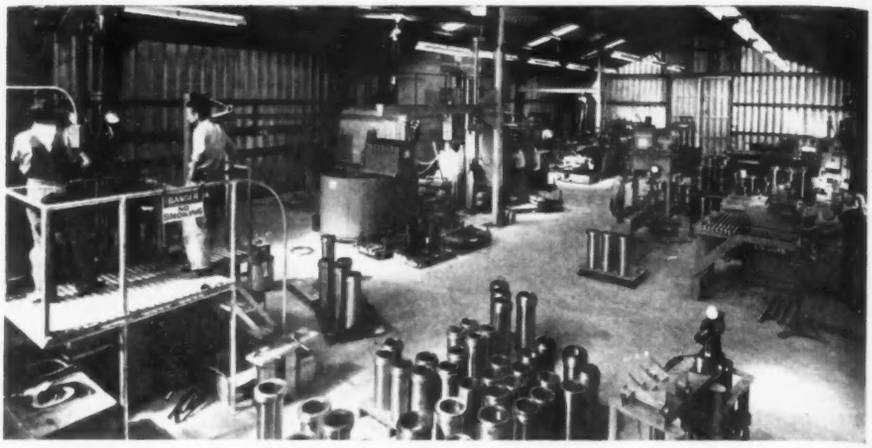
For more data on advertised products, use Readers' Service Cards, last page.

Suppliers' notes

American Iron Completes New Rod and Liner Plant

American Iron & Machine Works, Inc., of Oklahoma City, recently completed its new rod and liner plant and has announced that the plant is now in full operation.

The modern plant features the newest machines available for the precision manufacturer of slush pump rods and liners. One of the most important new additions to the plant is an automated electronic induction hardening machine, designed and built especially for American Iron. Complete electronic controls assure fast, uniform, depth-hardening of liner bore. There is no overheating of the bore surface, which insures a longer life of the liner.



This panoramic view of American Iron's new rod and liner plant shows the new Micro-Matic honing machine on the left which is electronically controlled. In the center is the new automated electronic induction hardening machine.

Also included in the new plant is a large micromatic honing machine which is electrically and hydraulically controlled to assure straight, accurate precision bore. An unusual twin-spindle boring machine is also a new feature of the plant. It was designed exclusively by American Iron and gives added stability and more accuracy of boring.

A special Rockwell hardness tester is used by American Iron inspectors for checking the Rockwell hardness of every liner.

The opening of the new plant is part of American Iron's long range expansion plans into other areas of manufacturing for the petroleum industry.

Bradford Motor Works Buys Stock of Chas. N. Hough

Bradford Motor Works, Inc., has purchased the capital stock of the Chas. N. Hough Company, of Franklin, Pa.

Plant facilities of the Hough Company will be transferred to Bradford, Pa., soon, along with administrative operations. No change will be made in sales personnel for either company at present and Hough's Tulsa warehouse also will be maintained.

Columbia Well Service, Inc. New Mississippi Company

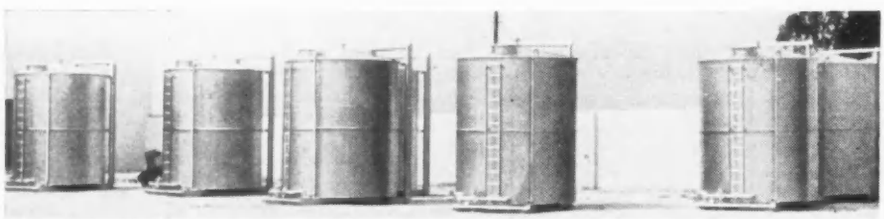
Columbia Well Service, Inc., has recently been organized by the late Jesse R. Wilkins and will be operated out of Columbia, Miss., by Jesse R. Wilkins, Jr., and Robert L. Kemp.

The new firm will utilize a new Fred E. Cooper 138 swabbing unit capable of 12,000 feet swabbing and mounted on a 190 International Tandem truck. Also mounted on the truck will be a 50 foot high mast hydraulically raised and telescoped.

Braby OILFIELD EQUIPMENT

our range of products for the Oil Industry includes

GENERATING SETS
POWER HOUSES AND RIG UTILITIES
POWER PACKS AND TWIN UNITS
SELF PRIMING PUMPS UP TO 8"
DOG HOUSES AND TOOL HOUSES
FEED CONTROL SYSTEMS
WELDED AND SECTIONAL BOLTED TANKS
A.P.I. TANKS
SHALE SHAKERS
COMPLETE OILFIELD CAMPS
RIG AND CAMP LIGHTING SYSTEMS



A line of A.P.I. Tanks as supplied by Braby for use by an oil company in Libya.

Full Details on Application FREDK. Braby & CO. LTD.

OILFIELD DIVISION
BRABY HOUSE, SMITHFIELD STREET
LONDON E.C.1. ENGLAND

Phone: CENtral 2388
CABLES: XENOPHON CENT LONDON

MEMBER OF BRABY OF BRITAIN GROUP

NOW-from O·C·T

greater flexibility and simplicity in tubingless completion equipment

The challenge was tubingless completion equipment featuring simplicity, flexibility, utility and "controllability." And here is the answer.

- Hangers are interchangeable. Thus, one, two, three or four strings of tubing can be hung in a head simply by changing hangers. Moreover, screwed or slip type interchangeable hangers are provided. Regular hanger couplings can be provided with or without the back pressure grooves.
- The complete series of hangers is produced to fit O-C-T Type CM, C-18, or C-19 Casing Heads and hangers for C-18 and CM heads are interchangeable. All hangers are designed to allow conventional cementing procedures, even providing for reciprocation of the tubing while cementing and simultaneously cementing through two or three strings of tubing.
- The Christmas Trees for use with O-C-T tubingless completion equipment can be provided with screwed connections, individually flanged connections or block type valves in the case of duals, triples or quadruples.
- For use with the several types of trees, O-C-T manufactures a complete line of 2½-inch tubing heads in which ¾-inch through 1½-inch tubing can be hung with any one of a complete family of interchangeable hangers.
- All hangers are designed to be run through blowout preventers.
- Available in pressure ratings up to and including 10,000 psi working pressure.

If you want to take advantage of tubingless completion on your next well, talk to the O-C-T representative nearest you. He can show you the best in tubingless completion equipment.

O·C·T

OIL CENTER TOOL CO.

SUBSIDIARY OF FOOD MACHINERY AND CHEMICAL CORPORATION

Address Export Inquiries for All Countries to
P. O. Box 3091, Houston, Texas.

where progress is a daily practice

MARTIN RUBBER & DUCK RINGS give excellent life in dirty abrasive fluids . . . high or low gravity . . . much or little water . . . shallow or deep wells. They last for years in the easier pumping wells. Replacement rings cost comparatively little.

MARTIN PLUNGER BODIES, precision grooved, drilled and threaded (no underneath fluid passage), usually last for years. Tube or barrel costs are often cut in half.

The replaceable SYNTHETIC RUBBER GUIDES in MARTIN CAGES last longer than any metal, and the cushioning of the ball increases your ball & seat life. Results are often truly amazing. (Patent No. 2,591,174)

Write for our new catalog or see it in the Composite (24th Edition). All products sold thru supply companies.

JOHN N. MARTIN
Manufacturer
9 W. BRADY STREET • TULSA, OKLAHOMA

SQUEAKS
From the Bull Wheel

Without Reservations

I met my wife at a travel bureau. She was looking for a vacation and I was the last resort.

Just Take a Gander

The city girl said to the farmer, "Oh, look at the pretty geese. But tell me, how can you tell the geese from the ganders?"

"To tell you the truth, Miss," answered the farmer, "I just let them figure it out for themselves."

Like Father—Like Son

Junior: "Dad, did you go to Sunday School when you were a little boy?"

Father (smugly): "I sure did. Never missed a Sunday."

Junior (turning to his mother): "There now, Mom. Don't you see? It won't do me any good either."

Where's the Connection?

"You've been charged with fighting," said the judge. "Have you any explanation?"

"Well, your honor," said the defendant, "I was in a phone booth talking to my girl when this guy comes up and wants to use the phone. He opens the door, grabs me and tosses me out on my ear."

"Then you got angry?" asked the judge.

"Yes, a little," answered the man, "but I didn't get real mad until he grabbed my girl and threw her out too."

Being Real Suave

"Shay, lady, you're the homeliest woman I ever saw."

"Well, you're the drunkest man I ever saw."

"I know, lady, but in the morning I'll be sober."

Just Being Helpful

Fellow to blonde at cocktail party: "May I join you?"

"What's the matter?" she asked, "Am I coming apart?"

Budgeting Wife

A wife made an effort to balance her budget and check book. Finally she handed four sheets of figures with items and cost neatly typed to her husband.

He looked them over. Everything was clear except one item which read ESP, $24.50. Warily he asked, "What does ESP mean?"

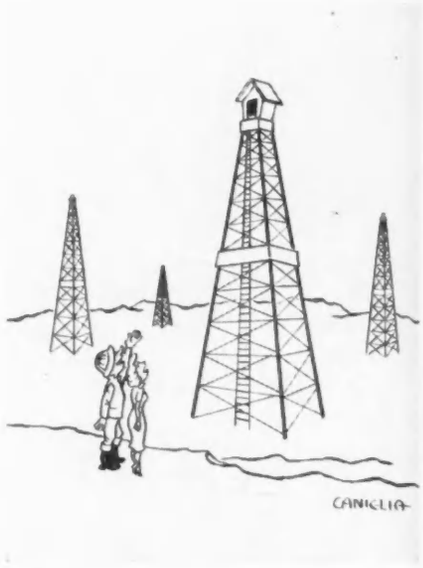
"Error some place," came the reply.

Just a Little Shy

"How old did you say you were?" asked the doctor of his female patient.

"I never mention age," replied the patient, "But as a matter of fact, I've just reached 21."

"Indeed," said the doctor. "What detained you?"



WORLD OIL
"Well, there's the penthouse I promised you!"

Business Before Pleasure

The young bride was having her new house decorated and while changing into something suitable for her afternoon bridge club, she noticed what appeared to be her husband's hand print on the wall in the bedroom that had been freshly painted the day before. She slipped into a filmy but adequate covering and, going to the head of the stairs, called down to the painter who was now working in the living room.

"Pardon me, but would you like to come up here and see where my husband put his hand last night?" she said.

"I'd love to lady," replied the painter, "but I've got to get done with this painting."

A Secret Is a Secret

The newlyweds asked the Pullman porter not to spread the word around that they were just married, because they didn't want to be stared at. But the next morning, to their surprise and dismay, they found that everyone in the car was staring at them. They asked the porter whether he had told them.

"Oh no," he answered, "I didn't tell them you were newlyweds. I told them you were just good friends."

Which is Which?

"I hear you married one of the pretty Robbins twins, George. How do you tell them apart?"

"I don't try."

A Close Call

Barber: "Haven't you been in here before?"

Customer: "No, I lost that car in an automobile accident."

True to Life

No man is entirely worthless. If nothing else he can always serve as a horrible example.

Thoughtfulness

Husband: "I bought something today for the one I love best. Guess what."

Wife: "A box of cigars."

Speaking Frankly

Psychiatrist to patient: "Despite what you think, Mr. Jones, you don't have a complex. Actually, you ARE inferior."

In No Condition

Spifflicated Truck Mechanic: "Shay, lady, muh shigaret lighter quit, ya gotta matsch?"

Hoity-Toity Dowager: "Why you drunken beast. You don't need a match. You're lit up like a Christmas tree already. If I were in your condition I'd shoot myself."

Spifflicated Truck Mechanic: "Yesh, and if you wush in my condishion, you'd mish."

Just Plain Kids

Nine-year-old David hurried off to school one morning before his mother inspected his wash job. So, when he sat down in the classroom, breakfast was still visible on his face.

The teacher frowned and said reprovingly: "David, you didn't wash your face. What would you say if I came to school one morning with egg on my mouth?"

"Nothing," he retorted smugly. "Nothing at all. I'd be too polite."

Thinking for Himself

"Now, then, Tommy Brown," said the teacher, "I want to set you a little problem. Suppose there were five children and their mother had only four potatoes to share among them. She wanted to give each child an equal share. How would she do it?"

"Mash the potatoes," said the boy.

The End's The Same

Hank: "How did you lose your hair?"

Ted: "Worry."

Hank: "What did you worry about?"

Ted: "About losing my hair."

Short and Sweet

The girl smiled at the waiting line as she went into the phone booth.

"I won't be long." she said. "I just want to hang up on him."

Think First

Sign on door of Marriage License Bureau: "Out to lunch. Think it over."

Eating His Heart Out

Man in restaurant to waiter: "What's our offense? We've been on bread and water for almost an hour."

Changing Times

"You don't sell used cars? What kind of a drug store is this?"

Facing Reality

Who are you to question your wife's judgment? Look who she married.

Tired From Being Tired

Trying to rest after an exceedingly hard day at the office, poor father was being bedeviled by a stream of questions from little Herkermer. "What do you do down at the office?" Herkermer finally asked.

"Nothing," shouted the annoyed father.

After a thoughtful pause, Herkermer inquired, "Then how do you know when you're through?"

A Lesson Well Learned

Young Son: "Dad, Mom just backed the car out of the garage and ran over my bicycle."

Dad: "Serves you right for leaving it on the front lawn."

A Friend in Need

"Sometimes," said Mrs. Thorndale to the new maid, "it will be necessary for you to help me upstairs."

"I understand, ma'am," replied the new maid, "I drink a bit myself."

Danger—Handle with Care

As one old bachelor puts it, "If you don't think women are explosive, try dropping one."

WORLD OIL'S Trading Post

CLASSIFIED ADVERTISING

RATES: Regular Classified (undisplayed) set in this size type: 20 cents per word. **Minimum** charge $4. Blind box address in our care counts six words. Replies forwarded without charge. **Display Classified ads,** set in suitably larger type with ruled border, $13.50 per column inch. Ten percent discount for two or more insertions of same copy in consecutive issues. **All classified ads payable in advance.** Send copy and checks to: Trading Post Classified Section, World Oil, P. O. Box 2608, Houston, Texas.

FOR SALE

■ CORE DRILL OPERATORS. We purchased Government Surplus core drilling equipment. Will offer at big money-saving prices. Contact Pressey & Son, Pueblo, Colo.

■ SALES AND RENTALS. New or used portable floating bridges, trestle bridges and ferrys. Bub Gallaway, 4106 Ascot Lane, Houston, Texas. Phone OV 2-2334.

■ Lovely property facing Pikes Peak near Colorado Springs. Will consider some Oil Stock in exchange. Charles McKillips, 840 Sherwood Drive, Beloit, Wisconsin.

■ For Sale 10,000 acre Oil & Gas leases, Sismographed, shallow drilling, $3 per acre 5% overide, P. O. Box 236, Logan, Utah.

■ Portable Spudder. Cooper E563 excellent condition, on IHC truck. Inventory available. Box 736, Great Bend, Kansas, Phone GL 3-8817.

3000 CFM CHICAGO PNEUMATIC AIR COMPRESSOR

#9538 Type 180CT DE 23x13x18, Engineered & Rebuilt by Erl E Knox Co., Erie, Pa., 600 hp 200 rpm Syn Motor, Rebuilt and Installed 1952, Run Less Than 6 Mo. Prior to Plant Shut Down, Large Number Spare Parts—$18,500.00 F.O.B. Car San Diego.

CARVER ELECTRIC COMPANY
P. O. Box 845, Coos Bay, Oregon

SITUATIONS WANTED

■ Capital needed to drill offset production in Ohio and W. Va. Oil bringing 4.17 per BBL. Gas .25¢ per thousand. David W. Law, 716 Union Trust Bldg., Parkersburg, W. Va. Phone: HU 5-6446.

NOTICES, SERVICES

■ Consulting service available in all phases of natural gas compression and treating. Specialized service in natural gasoline plant economics, design and operation. Address replies to Box 220-W, c/o WORLD OIL, Houston, Texas.

■ Oil Field Tools and Equipment Sales Representation for American manufacturers, offered for Italy and North Africa especially, by Italian Engineer, retiring from large Company. Highest References Italy and U. S. Address Box No. 221-W, c/o WORLD OIL, Houston, Texas.

Oil Industry Cartooning

Oil Industry Gag & Spot cartoons for house organs, magazines, and papers...

Write...

Alvin H. Bloodworth
1838 South Euclid, Ontario, California

LEASES, DRILLING, ACREAGE, ETC.

■ Have thousands of acres in Ohio and W. Va. close to Big Play, to farm out. We have a very competent Land Department. Will take leases on your lease form. David W. Law, 716 Union Trust Building, Parkersburg, W. Va. Phone: HU 5-6446.

SECONDARY RECOVERY

PETROLEUM ENGINEERS
STEPHENS ENGINEERING
WICHITA FALLS, TEXAS

RESERVOIR ENGINEERING

Water Flooding **Gas Repressuring**

EVALUATION CORE ANALYSIS
SURVEYS ECONOMICS

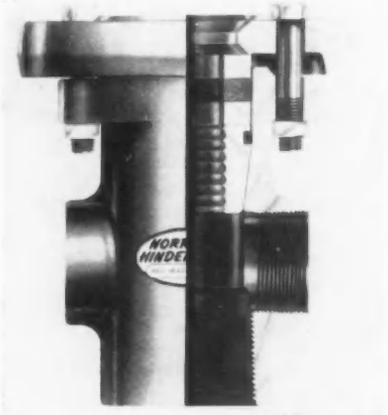
Cost Estimates, Design, Installation
FIELD SUPERVISION
Phone 723-2167

NEW equipment and services

New Equipment Carrier

This new 8 x 4 oil field equipment carrier has been introduced specifically for oil field service applications. Features include: power steering, welded construction frame with 18-inch "I" beams and FWD's exclusive "guitar" drive-through tandem rear axles, permitting one drive shaft instead of the usual two. The 95-foot mast folds down over the cab for over the highway travel. Both the mast and drawworks are powered by the carrier engine. (FWD Corporation).

For more data, circle E1 on postcard



Slim Hole Tubing Head

A new, low cost slim hole tubing head has been developed for use in slim hole completions. Known as type S L tubing head, it is available with a 2½-inch EUE 8 round female bottom thread. Head will suspend ¾ inches, 1 inch or 1¼-inch upset or non-upset tubing, or 1½-inch non-upset tubing with either mandrel or slip suspension. Rated at 1,000 psi test and 500 psi working pressures, a top cap provides a convenient base for tubing spider. (W. C. Norris, Division of Dover Corp. Supplements data on Pages 4013-4036, 1960-1961 Composite Catalog).

For more data, circle E2 on postcard

Drive-In Rambler Rigs

Six sizes of Ideco Drive-In Rambler Rigs, ranging from 114 to 395 hp, are now available. According to the manufacturer, Drive-in ramblers are the answer to medium-depth drilling. Faster moves, faster rig-up, faster work and faster rig-down are the trademarks of the rambler rigs. Special features include driver's unrestricted view of road and location because of forward-mounted cab; handwheel back guy adjusters plumb mast over well, and a cross-over type crown block. (IDECO, one of the Dresser Industries. Supplements data on Pages 2897-2944, 1960-1961 Composite Catalog.)

For more data, circle E3 on postcard

Overload Protection

A new kind of overload protection for oil well pumping motors has been announced. The simple, fast-acting Thermo-Tector protection system is available on all the company's Tri-Clad '55 oil well pumping motors, Type KOF, 5 to 75 horsepower, in frame sizes 254U to 445U. Protection is provided by two or more miniature heat-sensing switches buried in the stator windings. Thermo-Tector system is "fail safe." Any break in wires, switches or connections acts to stop the motor. (General Electric Company.)

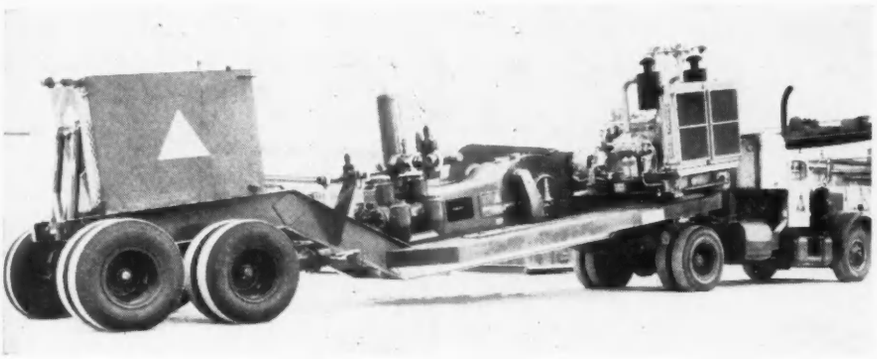
For more data, circle E4 on postcard

Drilling and Bumper Jar

This combination drilling and bumper jar features compact design and rugged construction to produce efficiency, utility and economy. It performs a number of downhole drilling and jarring operations which formerly required two tools. Primary uses include: As a drilling jar, for freeing stuck drill pipe. As a feed-off jar, maintains controlled weight of bit. As bumper jar, for releasing other tools in the string. (Hunt Tool Company. Supplements data on Pages 2713 - 2760 & 1848A - 1848D, 1960-1961 Composite Catalog).

For more data, circle E5 on postcard

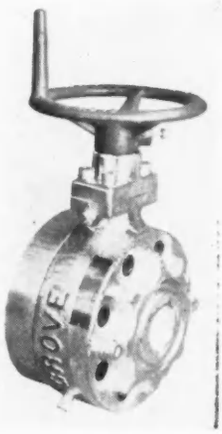
New equipment



Trailerized Slush Pump

This new trailerized slush pump unit operates with the trailer frame resting upon the ground. Because of the low level of operation, it is simpler to maintain a flooded suction than with conventional trailer mounting. With pump operating from a base upon the ground, the wheels are suspended in air and no jacks are required. Pump vibrations are dampened and a minimum of matting is necessary. (Continental-Emsco Co., A Division of Youngstown Sheet & Tube Co. Supplements data on Pages 1397-1484 & 1485 & 1549, 1960-1961 Composite Catalog).

For more data, circle E6 on postcard



Regular Port Valve

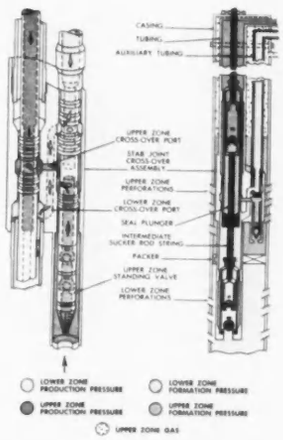
This new regular port valve has been designed for general production and pipe line service. Can be used in Christmas Tree assemblies or as a wing valve, casing head valve or tubing head valve. With each operation the metal seats strip foreign matter from the gate while the "O" rings squeegee and polish both faces. Always in contact with the gate, seating surfaces are isolated from corrosive and erosive elements in the line. No lubrication is required. (Grove Valve and Regulator Company. Supplements data on Pages 2253-2260, 1960-1961 Composite Catalog).

For more data, circle E7 on postcard

Versatile Pilot Mill

A new A-Z Type R Pilot Mill has been designed with easily replaceable blades to make it especially useful for meeting many job requirements in remote locations. Features include long tapered pilots to prevent side-tracking when used in open hole work, protective pads to prevent injury to wall of casing string when used in casing and heat treated alloy steel bodies. (A-Z International Tool Company. Supplements data on Pages 97-116, 1960-1961 Composite Catalog).

For more data, circle E8 on postcard



Two-Zone Pump Design

This new pump design offers the advantages of a long stroke Two-Zone Pump for a maximum production. It can be installed under the Axelson 26½-foot hydraulic pumping unit if maximum production is desired. Fea-

For tighter grip, longer life and maximum safety! Regular tooth or cross cut.

AT SUPPLY STORES EVERYWHERE!

DRILLING EQUIPMENT MANUFACTURING CO.
845 S.E. 29th
Oklahoma City, Oklahoma
DEMCO

PERFORATE TUBING IN THE WELL

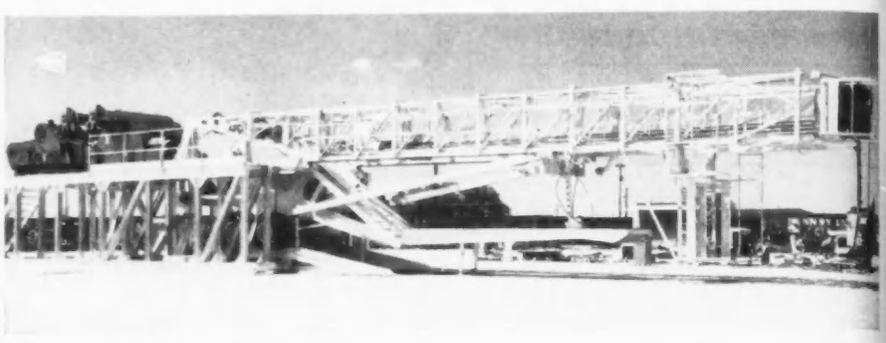
KINLEY TUBING PERFORATOR

J. C. Kinley Co. Licensees

ABILENE, TEXAS—Hudson-Eads, Inc.....OR 2-5331
ANACO, ANZUATEGUI, VENEZUELA
Anzoategui Wire-Line Service, C. A.
BAY CITY, TEXAS—J. P. Graham.....CI 5-4526
CABIMAS, ZULIA, VENEZUELA
Wireline Engineers, S. A.
CASPER, WYOMING—C. A. White.....3-5264
CORPUS CHRISTI, TEXAS—Tolle, Inc...TE 5-5367
CORPUS CHRISTI, TEXAS
J. D. Ball Wire Line Service Co.....TU 3-7762
FARMINGTON, NEW MEXICO
B & R Service, Inc.....DA 5-2393
FORT MORGAN, COLORADO—C. A. White...919
GLENDIVE, MONTANA—C. A. White...EM 5-3833
HOBBS, NEW MEXICO
Horne Well Service Co.....3-5396
HOUMA, LOUISIANA
Assoc. Eng & Equip., Inc.....UP 2-0347
HOUMA, LOUISIANA—Camco, Inc.....7330
HOUMA, LOUISIANA
Fred Haynie Oil & Gas Well Service...UP 3-7885
HOUSTON, TEXAS
Mid-Western Well Ser. Co.....RE 4-4262
HOUSTON, TEXAS
Long Line Production Control.....GR 3-5739
LAFAYETTE, LOUISIANA—Camco, Inc. CE 5-3124
LIBERAL, KANSAS—Rainbo Service...Main 4-3598
MIDLAND, TEXAS
Luccous Service & Eqpt. Co.....MU 2-8311
NEW IBERIA, LOUISIANA
Cardinal Wireline Specialists, Inc.....EM 4-5165
NEW IBERIA, LOUISIANA
Klein-Deco Wire Line Service.....EM 9-6632
ODESSA, TEXAS
Camco Wire Line Service, Inc.....FE 2-6497
ODESSA, TEXAS
John Kuykendall Wireline Service Co...FE 7-7210
OKLAHOMA CITY, OKLAHOMA
Rainbo Service Co.....ME 4-2131, ME 4-0105
PETTUS, TEXAS
Eddie Jones Eng. Co., Pettus 16, Beeville FL 8-1218
SHREVEPORT, LOUISIANA—Camco, Inc....8-3615
VICTORIA, TEXAS—Camco, Inc.....HI 3-9521
WICHITA FALLS, TEXAS—Tudson-Eads, Inc.
322-8584, 322-1792, 767-8727, 723-4690, 767-3793

tures: The upper zone standing valves can be retrieved without disturbing the packer, main tubing string and the upper and lower zone pumps simply by removing the auxiliary tubing; available in 5½-inch casing and 6⅝-inch casing. (Axelson Division of U.S. Industries, Inc. Supplements data on Pages 269-340, 1960-1961 Composite Catalog).

For more data, circle E9 on postcard



Drilling Rig Arrangement

This new approach to drilling rig arrangement couples the mobility of trailer mounting with the stability of a conventional substructure. Mast travels on a single trailer, while the drawworks, compounding transmission and engines are substructure mounted. Rotary machine and a portion of the rotary drive guard are permanently mounted in the mast trailer with rotary chain in place. Telescoped mast travels with rotary line strung and hook block in place. (Continental-Emsco Company, a Division of Youngstown Sheet & Tube Co. Supplements data on Pages 1397-1484 & 1485 & 1549, 1960-1961 Composite Catalog).

For more data, circle E10 on postcard

The *New* PROVEN WAY to get the...

BEST CEMENT JOB

SPIN-O-LIZER CEMENT SPINNERS

Manufactured for All Sizes of A. P. I. CASING

SPIN-O-LIZERS take the doubt out of your cementing. Cement Bond Logs and Temperature Surveys have proven on well after well that SPIN-O-LIZERS give a more thorough and uniform cement job.

Avoid damaging your formation by using SPIN-O-LIZERS to eliminate the possibility of having to put a squeeze job on your formation.

★ ELIMINATES CHANNELING
★ REDUCES CONTAMINATION
★ SPACES MULTIPLE CASING STRINGS
★ CENTERS CASING
★ ACTS AS STOP COLLAR
★ MADE OF TENZALOY

Contact your favorite supply store, Clark Oil Tools or their representatives for SPIN-O-LIZERS, Clark Scratchers, Centralizers, and Stop Collars.

CLARK OIL TOOLS

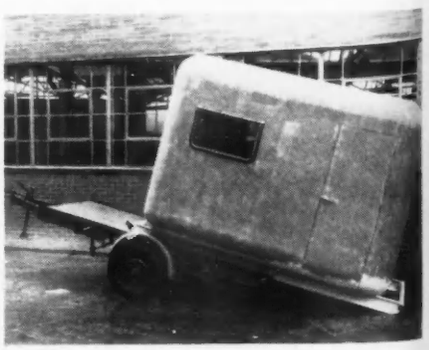
PH. 767-2440, WICHITA FALLS, TEXAS, P. O. BOX 238

REPRESENTATIVES
Roy Manning—Wichita Falls, Texas
Bill Whitaker—Throckmorton, Texas
Kenneth Clark—Alice, Texas
Owen Marsh—Tulsa, Okla.
Ben Bolding—Guymon, Okla.
B & R Service Co.—Farmington, N. M.
Dave Crancer—St. Louis, Mo.
John Raymond—Hutchinson, Kan.
Globe Oil Well Cementing Inc. Great Bend, Plainville, Hill City, and Kiowa, Kansas.

New Sucker Rod

A new ½-inch sucker rod for well pumping has been added to the National line of sucker rods. The new rod is being produced in 25-foot lengths, Grade 40 only. Grade 40 is a medium carbon, medium manganese steel and is recommended for use in handling moderate to heavy loads where little or no corrosion is encountered. The rods are normalized through their entire length to give a fine, uniform grain structure. (The National Supply Company. Supplements data on Pages 3849-3976, 1960-1961 Composite Catalog.)

For more data, circle E11 on postcard



Self-Loading Float

This self-loading float is a fibre glass shell which is composed of eight moulded sections, bonded and bolted

SALZGITTER
FULL VIEW MAST

(GULLIVER)

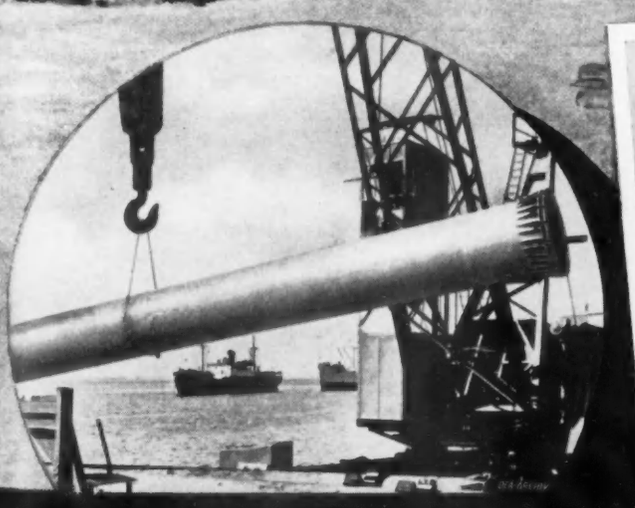
the latest in oil well drilling equipment

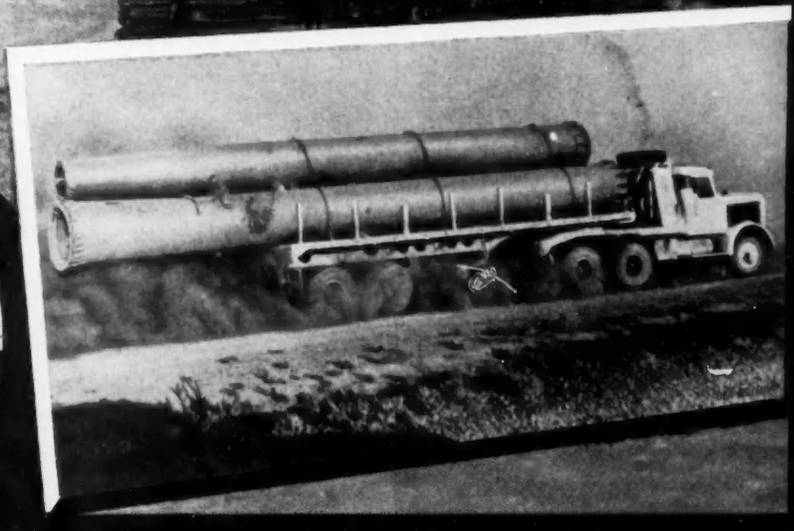
Salzgitter masts offer four unique features:

- quick and easy transport in 5 units
- fast assembly and erection
- unobstructed view during drilling operations
- cutting drilling costs

Our team of skilled engineers is at your service for consultation and assistance.

Salzgitter masts have become a familiar sight at many oil fields in Europe and overseas, among them fields in Mexico, The Sahara, Egypt, Lebanon and Syria, and will soon be seen at many more fields throughout the world.





SALZGITTER MASCHINEN AKTIENGESELLSCHAFT

SALZGITTER-BAD (Western Germany)

3441 telex: samag sgtr 0953805 samag

New equipment

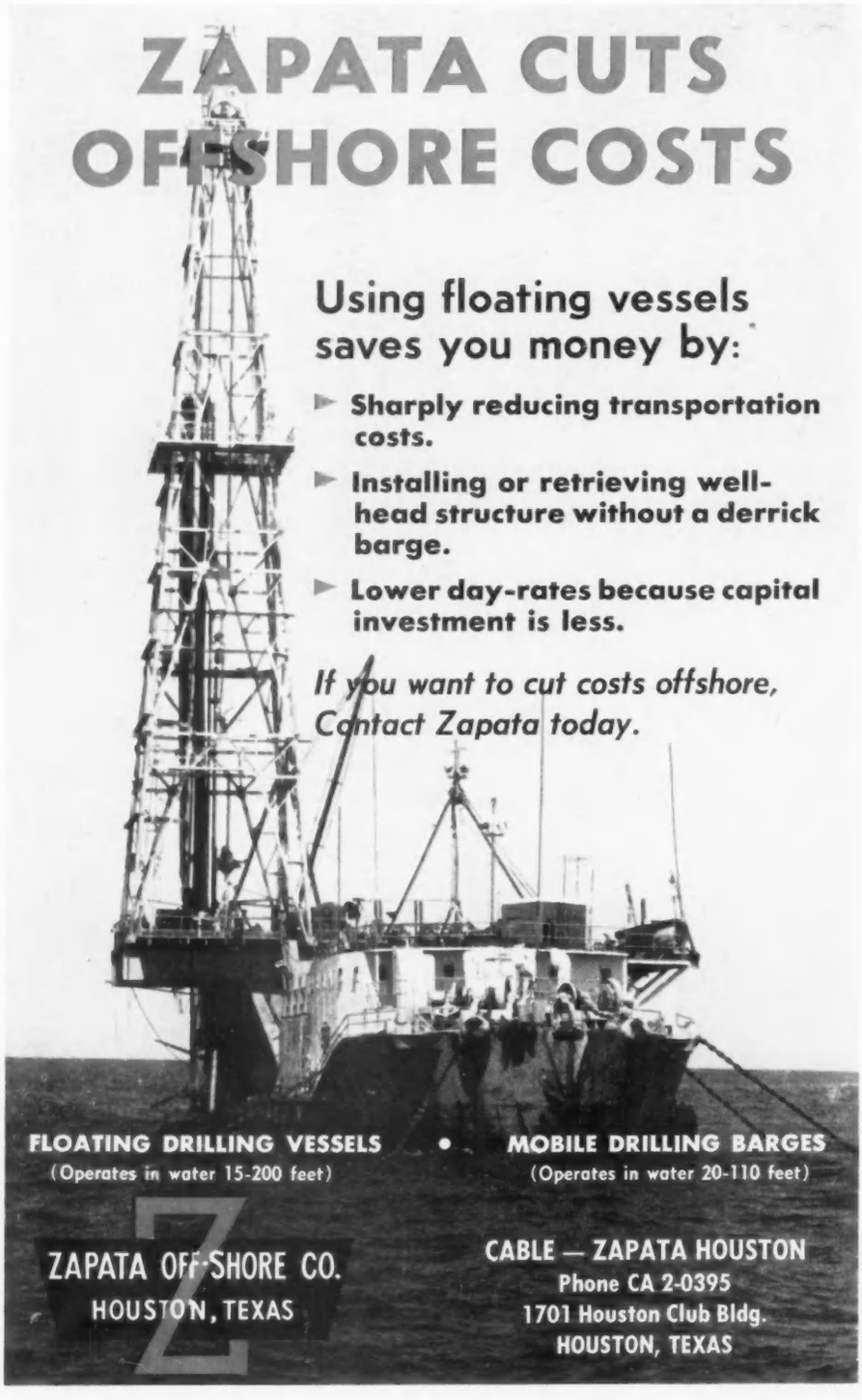
together. Ruggedly constructed, it has a one-ton winch mounted under the chassis by which means the skid-mounted unit is winched on to the trailer. For loading and unloading, requires only two men. In an emergency, one man could carry out the loading on his own. Complete shell is insulated with 1½-inch expanded polystyrene and internally faced with hardwood. (Scottorn Limited).

For more data, circle E12 on postcard

Salt Water Foaming Agent

A new foaming agent formulated specifically for air and gas drilling in the presence of salt water is now available under the trade name Afrox-200. Afrox-200 will turn even saturated salt water with as much as 10 percent oil contamination into aerated foam. Salt water intrusion of 50 to 60 barrels per hour can be handled under normal conditions. (Aquaness Department, Atlas Powder Company).

For more data, circle E13 on postcard


ZAPATA CUTS OFFSHORE COSTS
Using floating vessels saves you money by:
► Sharply reducing transportation costs.
► Installing or retrieving well-head structure without a derrick barge.
► Lower day-rates because capital investment is less.
If you want to cut costs offshore, Contact Zapata today.
FLOATING DRILLING VESSELS
(Operates in water 15-200 feet)
MOBILE DRILLING BARGES
(Operates in water 20-110 feet)
ZAPATA OFF-SHORE CO.
HOUSTON, TEXAS
CABLE — ZAPATA HOUSTON
Phone CA 2-0395
1701 Houston Club Bldg.
HOUSTON, TEXAS

Literature

To get your copies, circle key numbers on postcard and mail to WORLD OIL

Tubingless Completion Data

Baker Oil Tools, Inc., has introduced a new 8-page brochure which explains how the new Baker line of Tubingless Completion Equipment is used for completions utilizing tubing for small diameter casing. The booklet is divided into three sections: Primary Cementing, Remedial & Stimulation and Completion & Production.

To get a copy, circle E14 on postcard

Sand Control Bulletin

A new bulletin on their new line of prepacked screens is available from the Double Seal Company. Included in the bulletin are technical data, prices, descriptions and setting procedures for all seven of these sizes, including the new "Slim Hole" prepacked screen designed for either conventional or wire line operations including 2⅞-inch OD tubing.

To get a copy, circle E15 on postcard

Slurry Design Bulletin

The design of oil well cement slurries is described in a newly published technical bulletin by BJ Service, Inc. All commonly used cement slurries are compared on the basis of weight, volume, cost, thickening time and strength.

To get a copy, circle E16 on postcard

Cargo Trailers Literature

New literature, photographs and specifications are now available on the full line of Scottorn "Fezzan" heavy duty trailers from Scottorn Limited. Featuring all welded steel construction with progressive suspension and standard fittings, the line includes sizes of transport trailers as well as tank trailers suitable for use in remote locations.

To get a copy, circle E17 on postcard

Mud Additive Folder

Drilling Specialties Company has released a folder on its new drilling mud additive, Soltex. The folder also includes tables and also tells of the advantages of Soltex.

To get a copy, circle E18 on postcard

New literature

Rotary Valve Bulletin

A new Win-Well Green Triangle rotary selector valve bulletin, outlining various features and applications, has been published by Continental-Emsco Company. A complete listing of available sizes and models is also included in the bulletin.

To get a copy, circle E19 on postcard

Oil Field Motors Publication

A two-page publication which lists features and advantages of General Electric's new line of Tri/Clad '55' one to five horsepower oil field motors. Illustrated bulletin also contains tables of ratings, nomenclature and dimensions of the new motors.

To get a copy, circle E20 on postcard

Oil Field Motor Bulletin

A new oil field bulletin on Century Polyphase Squirrel Cage induction type motors, from 1 to 150 horsepower, has been issued by Century Electric Company. Bulletin discusses types SA, SCH, SCS and SCT motors. Also included are typical performance curves, application information, standard ratings and dimensions.

To get a copy, circle E21 on postcard

Capillary Inking Pamphlet

A cartridge-type capillary inking system is the subject of a new four-page bulletin just released by Hagan Chemicals & Controls, Inc. Diagrams and pictures of the system's operating functions are also included in the bulletin.

To get a copy, circle E22 on postcard

New FLAC Brochure

Dowell Division of The Dow Chemical Company has just published and released a new brochure on FLAC (Fluid loss additive, cement). In the form of a technical report, the brochure gives the description of FLAC, its advantages, suggested uses of FLAC, field applications, laboratory data, as well as graphs and tables.

To get a copy, circle E23 on postcard

Best Break Yet!
FOR
DRILL COLLARS
& TOOL JOINTS

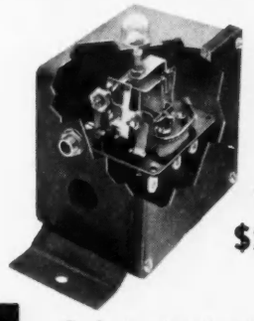
JET-LUBE WORLD WIDE

Full string service "from Swivel to Bit." Outstanding anti-seize and sealing properties. Exclusive formula. Mfd. under U.S. Pat. No. 2,543,741

JET-LUBE INC. Burbank, Calif.

EXPORT OFFICE:
30 Rockefeller Plaza, N.Y. 20

VIBRATION and SHOCK SWITCH!



VS-1
$29.50

Explosion Proof add $23.50.

MURPHY

Sensitive to abnormal oscillation in two planes of motion, recommended for use on engines, pumps, pumping units, compressors or any other equipment subject to destructive motion.

Same model can be wired to ground ignition, sound alarm, activate control panel lights, or operate valves such as Diesel fuel shut-off valves, and electric motor controller circuits. Rated at 5 Amps, 110 V AC.

•

Also safety switch-gauges to protect engines and equipment against any type of malfunction.

Time, temperature, pressure, level controls, automatic engine or motor controllers and complete control panels.

At your engine dealers or write:

FRANK W. MURPHY MANUFACTURER, INC.
P.O. BOX 4007
RANCH ACRES STATION
TULSA, OKLAHOMA

MURPHY SAFETY SWITCH OF CALIFORNIA
11812 Davenport Road • Los Alamitos, Calif.

ALVIN
PLAZA
HOTEL
MAIN AT 7TH

Single $4.75 (without TV)
$5 to $7.50 (with TV)
Double $6.50 to $9.50

Located in downtown Tulsa. All rooms are completely air-conditioned with combination tub and shower, and circulating ice water.

NEW PLAZA CLUB for Hotel Guests
EXCELLENT FOOD — Popular Priced Coffee Shop — Buffet Lunch 11 AM to 2 PM in Tap Room

BANQUET & MEETING FACILITIES for groups of 10 to 250

TULSA
Oklahoma

Announcing the new

MILLER
"SLIM HOLE" SAND PUMP

Miller 2" OD Sand Pumps for 2⅞" OD "Slim Hole" completions are now available. The 2" OD Sand Pump, with accurately machined lug-type bottoms, is designed exactly the same as larger Miller Sand Pumps.

SAND PUMP SIZES

OD—2, 2½, 3, 3½, 4¼, 5, 5½, 7 in.

Lengths—20, 25, 30 ft. for 3" OD and larger pumps. 20 and 25 ft. for 2½" pump. 20 to 24 ft. for 2" pump.

Composite Catalog, Page 3688
Write for descriptive price list

MILLER SAND PUMPS

Miller Sand Pump Co.

General Offices, Box 4516
Oklahoma City 9, Okla.

EXPORT OFFICES
30 Rockefeller Plaza
NEW YORK CITY 20, N. Y.

Advertisers in this issue

• Dot preceding name of advertiser indicates that detailed data on products and services of the firm will be found in current 24th (1960-61) Revision of The Composite Catalog of Oil Field Equipment.

A

Aero Service Corp. 145
Alberta Trailer Co. Ltd. 117
• Allis-Chalmers 177
Alvin Plaza Hotel 182a

B

• Baash-Ross Division
Joy Manufacturing Co. 125
• Baker Oil Tools, Inc. ..... 24 and 120-121
Bank of the Southwest 157
• Baroid Division
National Lead Co. 29
Bendix International Division
The Bendix Corp. 18
• Bethlehem Steel Co. ..... 12, 57 and 119
Bethlehem Steel Co.
Supply Division 46-47
C. Blumhardt 126
• Thomas Boorn & Co. Ltd. 58
Frederick Braby & Co. Ltd. 162
The British Ceca Co. Ltd. 134
Harold Brown Co. 144
Burns Tool Co. 137

C

• Cabot Corporation
Machinery Division 37
• Cameron Iron Works, Inc. 43
• Chiksan Co. 31
Clark Oil Tools 174
Classified 169
The Colorado Fuel & Iron Corp. 122
• Colorado Oil and Gas Corp. 56
Compagnie General de Geophysique 54
• Composite Catalog 14-15
• Continental-Emsco Co.
A Division of The Youngstown
Sheet & Tube Co. ..... 8 and 128-129
W. H. Curtin & Co. 9

D

• Davey, Paxman & Co. Ltd. 108
C. Deilmann Bergbau G.m.b.H. 152
Diamond Alkali Co. 112-113
Diamant Boart S. A. 105
• Dover Corp. 141
Dowell ..... 16 and 150
• Dresser Industries, Inc. ..... 149 and 171
• Drilling Equipment Mfg. Co. 173a

E

• Eisenwerk Wuelfel 38
Engineering Enterprises, Inc. 123

F

Ford Motor Co. 10-11
• Franks Division
Cabot Corp. 37

G

General Portland Cement Co. 159
• Geolograph Oil Field Services 130
Geophysical Service, Inc. 27
Great Lakes Carbon Corp. 6-7
• Grove Valve & Regulator Co. 131
Gulf Publishing Co. 180c

H

• Halliburton Company ..... 59-60 and 166-167
• Hands-England Oilfield Equipment Ltd. 148
Haniel & Lueg G.m.b.H. 168
• Hardy-Griffin Engineering Corp. 143
• Herb J. Hawthorne, Inc. 158
• HOMCO 178-179
• Hughes Tool Co. 186

I

• IDECO Division
Dresser Industries, Inc. 171
International Harvester Co. 50
The International Nickel Co. 48

J

• Jensen Bros. Mfg. Co. 151
• Jet-Lube, Inc. 181a
Jones & Laughlin Supply Division 52-53
• Joy Manufacturing Co. 125

K

• Ken Corp. 153
• King Oil Tools 34b
• J. C. Kinley Co. ..... 138a and 173b
• Koehring Co. 111

L

• Lane-Wells Company 165
• Larkin Packer Co.
Division Koehring Co. 111
• The Layne and Bowler Co. 146
• Lone Star Steel Co. 2

M

• Mannesmann A. G. 154-155
• Marsh Instrument Co.
Division Colorado Oil and Gas Corp 56
• John N. Martin Manufacturer 164
• Martin-Decker Corp. 54
• McCullough Tool Co. 165
• McKissick Products Corp. 127
Midwest Oil Register, Inc 138b
• Miller Sand Pump Co. 182b
• Mission Manufacturing Co. 36
• Frank W. Murphy Manufacturer, Inc. 181b

N

National Bank of Commerce 140
National Lead Co. 29
• The National Supply Co. 19-20-21-22
• W. C. Norris Division
Dover Corp. 141

O

• Oil Center Tool Co. 163
• Oil Well Supply Division
United States Steel 33

P

• Pan Geo Atlas Corp. 57
Petty Geophysical Engineering Co. 132
• Pittsburgh Steel Co. 142
• Pont-A Mousson 172
• Pontex Pipe Corp. 172
• Porta-Kamp Mfg. Co. 41
Prakla 160

R

• Reall Coachbuilders, Ltd. 147
• Reed Roller Bit Co. 39
• Regan Forge & Engineering Co. 124
• Rockwell Manufacturing Co. 115
John A. Roebling's Sons Division
The Colorado Fuel & Iron Corp. 122
• Rotary Oil Tool Co. 156

S

• Salzgitter Maschinen A. G. 175
• Schlumberger Well Surveying Corp. 40
• Security Engineering Division
Dresser Industries, Inc. 149
• Shaffer Tool Works 139
• Smith Tool Co. 33
Solar Aircraft Co.
Sub. International Harvester Co. 50
• Sperry-Sun Well Surveying Co. 40
Stephens Engineering 160
• Stewarts and Lloyds Ltd. 42

T

• Thompson Pump Co. 156
• Thornhill-Craver Co. 55
Timken Roller Bearing Co. 23
• Tretolite Co. 45
Trinity Portland Cement Division
General Portland Cement Co. 159

U

United States Steel Corp. ..... 18 and 33
• Universal Atlas Cement Division
United States Steel 180

W

• Warren Automatic Tool Co. 161
Wasag-Chemie AG 167
• Wells Equipment Mfg. Corp. 135
• Wilson Manufacturing Co. 34a
• Wilson Supply Co. 135
• Woodfield Rochester Lt. 44

Y

• The Youngstown Sheet &
Tube Co. ..... 8 and 128-129

Z

Zapata Offshore Co. 176

NORTH AFRIC

OIL AND GAS DEVELOPMENT

Map prepared for World Oil by

Macha Drafting Company • Cartographers • Houston, Texas

SCALE 1:4,786,000 OR 75.5 MILES TO THE INCH

0 25 50 75 150 225 300

STATUTE MILES

0 50 100 200 300

KILOMETERS

Published as a supplement to

WORLD OIL

January, 1961 issue

Copyright 1961 By Gulf Publishing Company

Extra copies of this map are available at $1 each. Send order to WORLD OIL, BOX 2608, HOUSTO

EXPLANATION

- OIL FIELD
- GAS FIELD
- OIL WELL
- GAS WELL
- CONCESSION
- REFINERY
- CITY WITH AIR FIELD

EXISTING — PIPELINES — PROPOSED

- CRUDE OIL
- GAS
- UNDER CONSTRUCTION

30

La Palma

Santa Cruz de Tenerife

Las Palmas

CANARY ISLANDS

Arrecife

Puerto de Cabras

M28

SS1 SS2 SS3 SS4

SS8 SS9 SS10 SS11

SS15 SS16 SS17

SS22 SS23 SS24

CA
NTS

USTON 1, TEXAS

10°

5°

PORTUGAL

SPAIN

Cartagena

NOTE: France is studying feasibility of moving gas to Europe via four, eight-inch lines from Mostaganem, Algeria to Cartagena, Spain.

Tangier

Tetuan

Oran

MIOA

35°

Melilla

CHELIF BAS

Petitjean Refinery

MIOB

Rabat

Casablanca

S.Kacem

MIC

MIE

Fez

Rharb Basin

Meknes

MID

A12A

Marrakech

MIB

Colomb-Bechar

S129

COLOMB - BECHAR BASIN

S55

S29

S1

Agadir

MIA

30°

Ifni

M4

S13

M3A

M3B

S54

TINDOUF BASIN

M2A

SS4 SS5 SS6 SS7

SS11 SS12 SS13 SS14

S131

S40

Adrar

S15A

S20B

MA

ATLANTIC OCEAN

SS22 SS23 SS24
SS30 SS31 SS32
SS39 SS40 SS41
SS43 SS44 45
SS47 SS48
SS52 SS53
SS51 SS56 SS57
SS60

15°

25°

SAHARA

SPANISH

Villa Cisneros

Fort Gouraud

Port Etienne

Atar

20°

MAURITANIA

MAI

Nouakchott

MA2

Kiffa

St Louis

SE1

Senegal River

Kaedi

SE2

SE3

SE4

15°

Dakar

SENEGAL

SE5

SE8

Noiro

SE6

SE9

SE7

GAMBIA

River

REGGAN BASIN

S39

S20B

S20A

S42

S30

M A L

Goundam

River

Gao

Nara

Mopti

Company • Cartographers • Houston, Texas

SCALE 1:4,786,000 OR 75.5 MILES TO THE INCH

0 25 50 175 150 225 300
STATUTE MILES
0 50 100 200 300
KILOMETERS

Published as a supplement to

WORLD OIL

January, 1961 issue

Copyright 1961 By Gulf Publishing Company

Extra copies of this map are available at $1 each. Send order to WORLD OIL, BOX 2608, HO

EXPLANATION

- OIL FIELD
- GAS FIELD
- OIL WELL
- GAS WELL
- CONCESSION
- REFINERY
- CITY WITH AIR FIELD
- EXISTING / PROPOSED PIPELINES
- CRUDE OIL
- GAS
- UNDER CONSTRUCTION

La Palma
Santa Cruz de Tenerife
Arrecife
Puerto de Cabras
Las Palmas
CANARY ISLANDS
M28
SS1 SS2 SS3
SS8 SS9 SS10
SS15 SS16 SS17
SS22 SS23 SS24
SS30 SS31 SS32
SS39 SS40 SS41
SS43 SS44 45
SS47 SS48
SS52 SS53
SS51 SS56 SS57
SS60
SAHARA
25°
15°
Villa Cisneros
SPANISH
Fort Gouraud

exas

08, HOUSTON 1, TEXAS

Cartagena

NOTE: France is studying feasibility of moving gas to Europe via four, eight-inch lines from Mostaganem, Algeria to Cartagena, Spain.

Tangier

Tetuan

Ora

35°

MIOA

Melilla

CHELI

Rabat

Casablanca

S.Kacem

MIC

MIE

Petitjean Refinery

MIOB

Fez

Rharb Basin

Meknes

Oum

River

MID

Marrakech

MIB

Colomb-Bechar

S129

COLOMB-BECHA

BASIN

S55

S29

Agadir

MIA

30°

Ifni

M4

M3A

M3B

S13

S54

M2A

TINDOUF BASIN

SS4

SS5

SS6

SS7

SS11

SS12

SS13

SS14

S131

S40

Adrar

S

A

REGGAN BASIN

S39

S42

S30

Port Etienne

Atar

20°

MAI

Nouakchott

MA2

St Louis

SE1

SE2

SE3

SE4

Kaedi

Kiffa

15°

Dakar

SE5

SE8

SE6

SE9

SE7

GAMBIA

SE10

SE11

SE12

Ziguinchor

Bissau

PORT. GUINEA

GUINEA

Noiro

15°

10°

A N

M A L

Goundam

Gao

Noiro

Nara

Mopti

Niger

Segou

Bamako

5°

0°

5° 0° 5°

PORTUGAL

SPAIN

MEDI

Cartagena

NOTE: France is studying feasibility of moving gas to Europe via four, eight inch lines from Mostaganem, Algeria to Cartagena, Spain.

Algiers

Bou

Tangier

Tetuan

Oran

Mostaganem

Set

M10A

A11C

A10B

A2

Oued Gueterini Field

A1A

Melilla

A10C

A10A

Tiaret

CHELIF BASIN

M10B

bat

S. Kacem

M1C

A13

ALGERIA

Fez

Meknes

Biskra

M1D

A12B

S6A

Laghouat

S57A

S5

S7A

A12A

S53

TRIASSIC BASIN

S4A

S3B

S59A

S48

S8A

S56

S44B

S56A

Ghardaia

S50A

S3C

S46

S45C

S2B

S3A

S9A

S47A

Ouargla

Colomb-Bechar

S129

S76A

S10A

S48

S45 B

S43A

COLOMB-BECHAR BASIN

S55

S2A

S50B

S49A

S29

S130

S1

S76 B

S10B

S47B

S11A

S71

El Golea

S69

S45 A

S11B

S70

S13

S28

S76B

S27A

S60

S14B

S27B

S14A

S16B

S18

MAC MAHON BASIN

S17

S40

Adrar

S15A

S15B

S16C

SAHARA

S16A

S20B

S21A

AGUEMOU

REGGAN BASIN

S39

S20A

S20C

In Salah

5°
10°
15°
35°
ITERRANEAN
SEA
Bizerte
Bougie
Bone
Philippeville
Setif
Constantine
A1B
Tunis
T4
Cap Bon
Field
CONSTANTINOIS
BASIN
Batna
A1C
T1B
skra
A11A
A1D
A11B
A1E
T3
Sfax
T5
Skhirra
S6A
S127
S6B
S78
S56B
S57B
S7A
S62
S7B
T2
T6
S59B
El Oued
S50D
ASIN
Touggourt
S43B
S44B
S8B
S64
S50E
Tripoli
PERMIAN
FLEXURE
L9
S76C
S45C
S50C
S52
T1A
Gulf
L38
S9B
L23
L34
L42
L83
L86
rgla
Hassi Messaoud
Field
S63
T1C
S73
S51
S117
L61
L8
S12
L70
Hassi El Gassi Field
GS-II Discovery Well
L39
L30
L4
L10
S69
S43C
S112
S87
L43
S49B
S104
L24
L60
L25
S19A
L26
S110
L40
L17
S19B
S72
S35
S36
S37
L69
L3
S34
L66
Mobil CEP Discovery
S19C
L49
L63
S32
L52
L62
Fort Flatters
S24A
S67
Ouan Taredjeli Field
S33
POLIGNAC BASIN
L78
S126
S25B
La Reculee
Field
S26
Zarzaitine Field
S74B
S81
S65A
Tiguentourine
Field
L1
L48
L50
S83
S66
S68
S75
Edjeleh Field
Taredert
Field
S25A
B-2
Atshan Well
Sabbah

S39

S20A

S20C

In Salah

AHNET BASIN

S21B

S22

S42

S30

S31

Gas Wells

MOUR BASIN

Tamanrasse

M A L I

Goundam

River

Gao

Niamey

S
PERM

C.F.P.(A
Petrol
S1 S3A S
S9A S
S27A

S.N.REPA
de Re
d'Expl
en Alg
S2A S2B
S8A S8
S28 S2

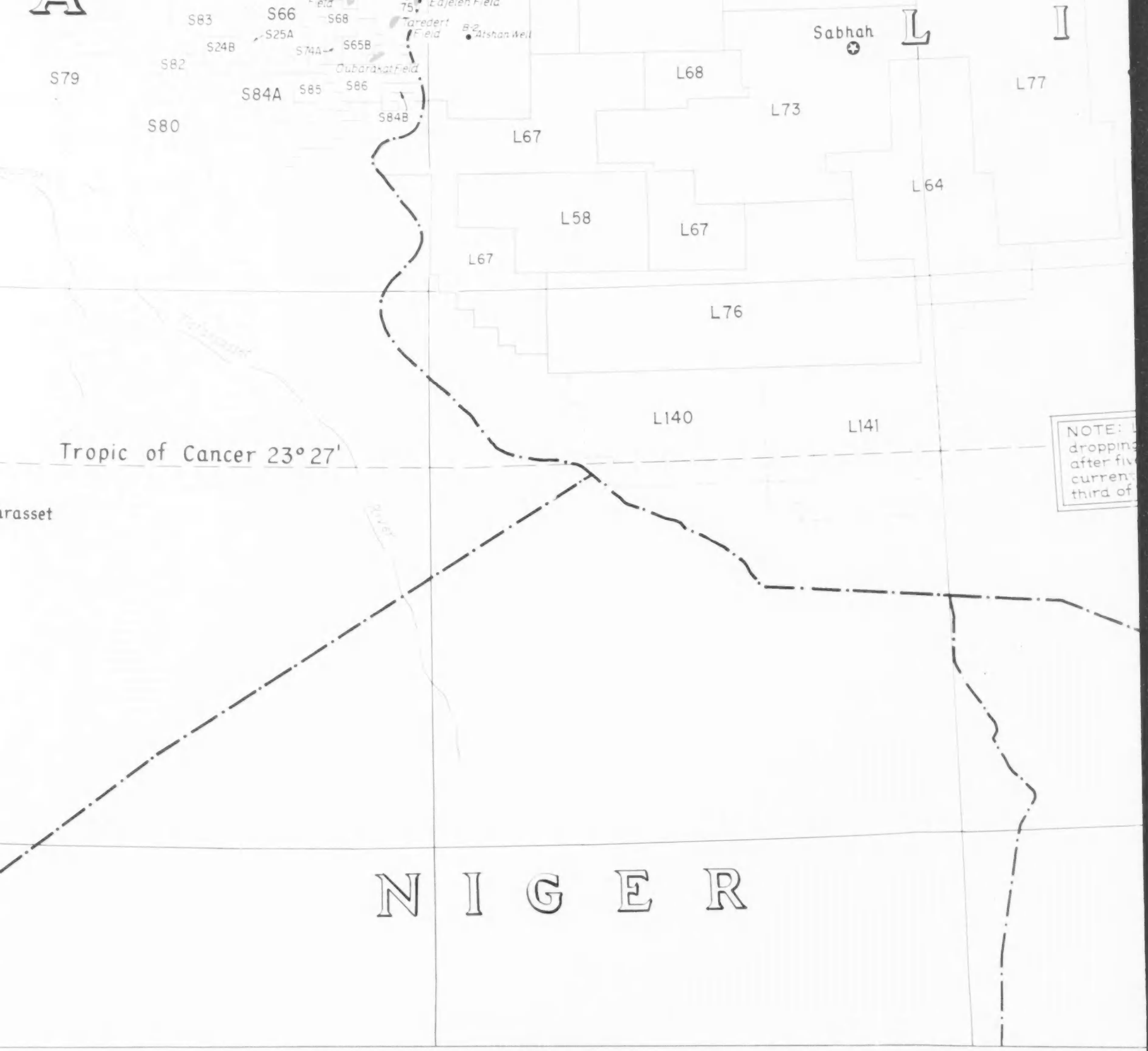
C.P.A. (C
d'Alge
S13 S14A
S16A S
S19A S
S47B S

C.R.E.P.S
Recher
de Petr
S20A S20
S22 S2
S25B S
S46 S8

C. E. P. (C
d'Explo

NOTE: France is st

Algiers



CONCESSIONS (INCLUDING PERMITS GRANTED AND REQ

SAHARA
PERMITS GRANTED

C.F.P.(A) (Cie Francaise Des Petroles Algerie)
S1-S3A-S3B-S3C-S5-S7A-S7B-S9A-S9B-S11A-S112B-S27A-S27B-S52-S53-S66

S.N.REPAL (Societe Nationale de Recherches et d'Exploitation des Petroles en Algerie)
S2A-S2B-S4A-S4B-S6A-S6B-S8A-S8B-S10A-S10B-S12-S28-S29-S51

C.P.A. (Compagnie des Petroles d'Algerie)
S13-S14A-S14B-S15A-S15B-S16A-S16B-S16C-S17-S18-S19A-S19B-S19C-S33-S47A-S47B-S63

C.R.E.P.S. (Compagnie de Recherches et d'Exploitation de Petrole au Sahara)
S20A-S20B-S20C-S21A-S21B-S22-S23-S24A-S24B-S25A-S25B-S26-S30-S31-S32-S46-S80

C.E.P. (Compagnie d'Exploitation Petroliere)

S.P.V. (Societe Petroles de Valence)
S44A-S44B-S55-S56A-S56B-S82-S84A-S84B

PREP-FRANCAREP-AFROPEC (Societe de Prospection et d'Exploitations Petrolieres en Alsace-Cie Franco-Africaine d'Exploitations Petrolieres Filiate Francaise de Cities Service)
S45A-S45B-S45C-S59A-S59B-S76A-S76B-S76C

PETROSAREP
S48-S58

COPEFA-OMNIREX-PHILLIPS (Cie des Petroles France-Afrique-Omnium de Recherches et d'Exploitation de Petrole)
S49A-S49B-S60-S71

S.A.F.R.E.P. (Societe Anonyme Francaise de Recherches et d'Exploitation de Petroles)
S50A-S50B-S50C-S50D-S50E-S54-S57A-S57B-S68-S83-S85

PETROPAR-FRANCAREP-FRANDEL
S61

S.N.REPAL-FRANCAREP-EURAFREP
S65A-S65B

PETROPAR-A.M.I.F.
S67-S70

COPAREX
S72-S81

C.F.P.(A)-PETROPAR-ESSO
S73

FRANCAREP
S74A-S74B-S86

EURAFREP
S75

TOPCO-CALASIATIC
S87

SAHARA (Permits Requested)

C.P.A.
S104-S117

C.P.A.-PETROPAR-FRANCAREP-FRANDEL-SAFREP
S112

C.F.P.(A), S.P.V., SAFREP
S126

FRANCAREP, S.N.P.A., COPEFA-PHILLIPS, PREPA, EURAFREP, S.N.REPAL, S.P.V., SAFREP
S130

PETROPAR-FRANCAREP-FRANDEL
S110

ALGERIA
PERMITS GRANTED

S.N.REPAL
A1A-A1B-A1C-A1D-A1E

CAREP (Compagnie Algerienne de Recherches et d'Exploitation Petrolieres)
A2

ALGERIA (Permits Requested)

CAREP
A-10A-A10B-A10C

S.N.REPAL
A11A-A11B-A11C

PREPA-FRANCAREP-AFROPEC
A12A-A12B

S.P.H.P. (Societe des Petroles des Moutes Plaines
A13

Nelson Bunker Hunt
L2-L65

Mobil Oil of Canada, Ltd.
L9-L10-L11-L12-L13-L14-L15-L50-L57-L62-L72

Libyan-American Oil Company
L16-L17-L18-L19-L20

Compagnie des Petroles Total
L23-L24-L49-L61

Oasis Oil Company
L25-L26-L27-L28-L29-L30-L31-L32-L33-L59-L60-L71

B.P. Exploration Co. (Libya) Ltd.
L34-L35-L36-L37-L63-L64-L80-L81

Libya Shell N.V.
L38-L39-L40-L41-L52-L69-L70

Texaco Overseas-California Asiatic (Amoseas)
L42-L43-L44-L45-L46-L47-L51-L73-L83

Gulf Oil Co. of Libya
L66-L67-L68-L79

Pan American Libyan Oil Co.
L74-L76-L84

Compagnia Ricerch (C.O.R.I.)
L82

Ausonia Mineraria
L85

Libyan Atlantic Co
L86-L87-L88-L89

LIBYA (Permits Re

Gulf Oil Co. of Libya
L136-L141-L142

Nelson Bunker Hunt
L130

Mobil Oil of Canada
L143

Pan American Libyan
L140

Shell Oil Company
L133-L144

MOROCC
PERMITS GRA

S.C.P. (Societe Cherifi Petroles)
M1A-M1B-M1C-M1D-

Bone

NOTE France is studying feasibility of moving gas to Europe via four, eight-inch lines from Mostaganem, Algeria to Cartagena, Spain.

Niamey

Algiers

Tangier

Tetuan

Oran

Mostaganem

Melilla

35°

M10A

A11C

A10B

A2

Oued Gueterin

A10C

A10A

Tiaret

CHELIF BASIN

Rabat

S.Kacem

M1C

Petitjean Refinery

M10B

Sebou River

A13

ALGER

lanca

M1E

Fez

Meknes

Fharb Basin

Moulouya River

A12B

Laghouat

S57A

M1D

A12A

Marrakech

S53

Hassi R'Mel Field

TRIA

S4A

S3B

S59

S58

S56A

Ghardaia

S3C

Colomb-Bechar

S129

S2B

S3A

S76A

S9A

COLOMB-BECHAR BASIN

S10A

S55

S2A

S29

S130

S1

S11A

El Golea

M4

S45

A

S13

S28

S76B

S27A

S14B

S27B

S14A

S16B

MAC MAHON BASIN

S17

S40

Adrar

S15A

S15B

S16C

SAHARA

S16A

S20B

S21A

AGUEMOUR BA

REGGAN BASIN

S39

S20A

S20C

In Salah

AHNET BASIN

S21B

S22

S42

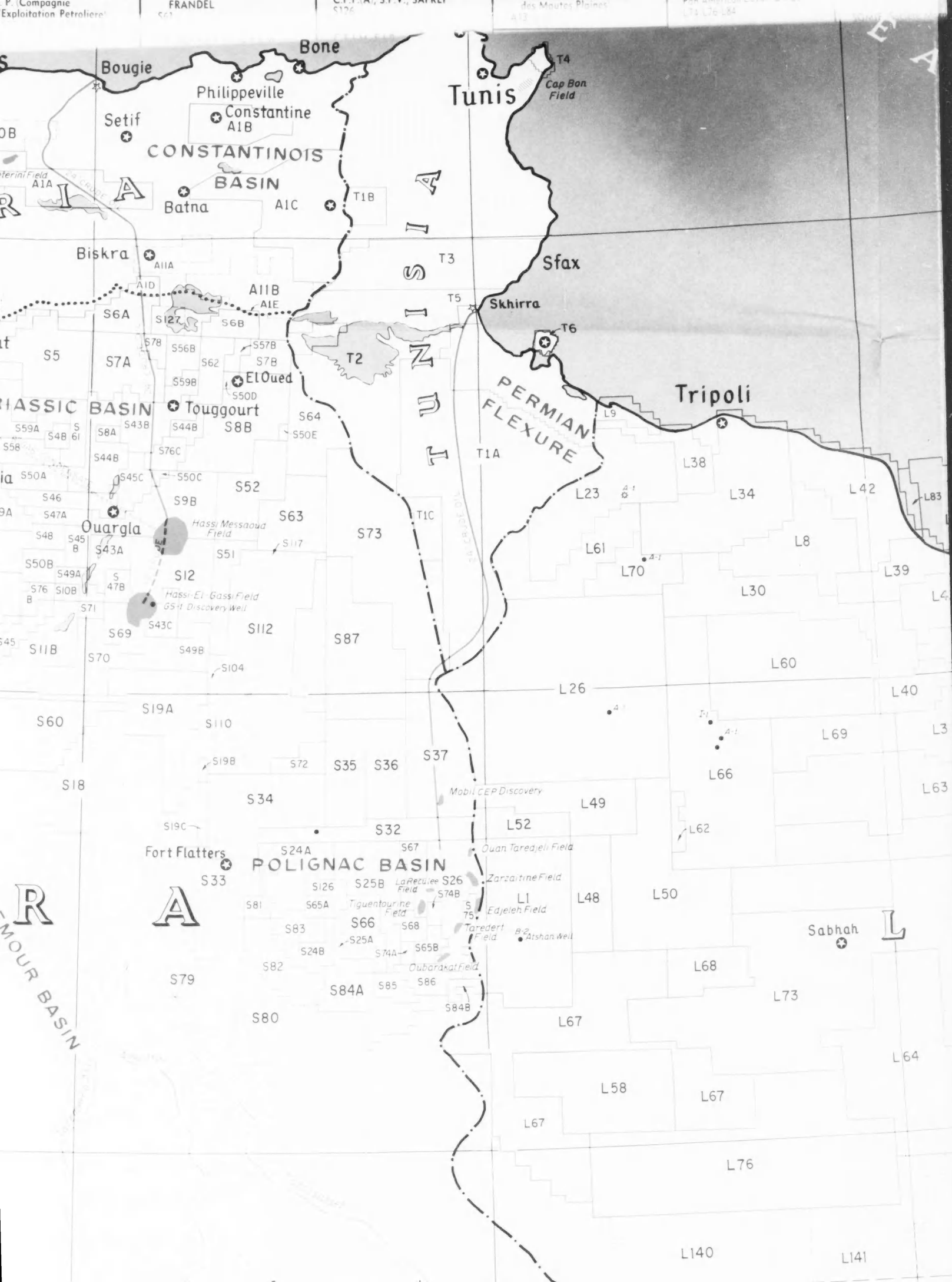
S30

S31

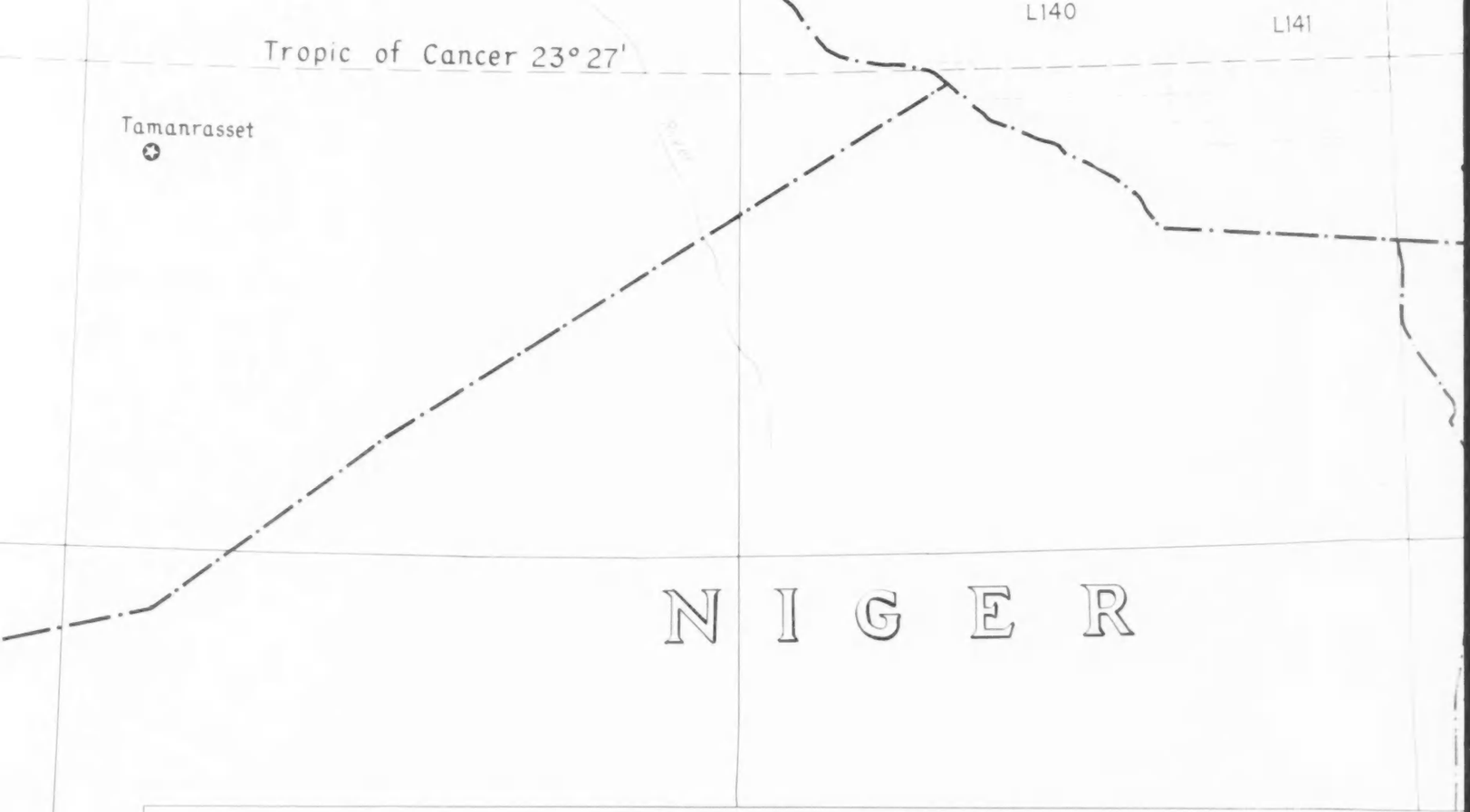
Los Angeles

DOUF BASIN

S54


Bone
Bougie
Philippeville
Constantine
A1B
Setif
CONSTANTINOIS
BASIN
Batna
A1C
T1B
Tunis
T4
Cap Bon Field
Biskra
A11A
A1D
A11B
A1E
T3
Sfax
T5
Skhirra
T6
S6A
S127
S6B
S78
S56B
S57B
S62
S7B
S7A
S5
T2
El Oued
S59B
S50D
BASSIC BASIN
Touggourt
S64
S59A
S4B
S8A
S43B
S44B
S8B
S50E
S58
S44B
S76C
T1A
PERMIAN FLEXURE
Tripoli
L9
L38
S50A
S45C
S50C
S52
L23
L34
L42
L83
S46
S9B
S47A
S63
T1C
Ouargla
Hassi Messaoud Field
S48
S45 B
S43A
S73
S117
S51
L61
L8
S50B
S49A
S12
L70
L39
S76 B
S10B
S 47B
L30
Hassi El Gassi Field
GS-1 Discovery Well
S71
S43C
S69
S112
S87
S45
S11B
S70
S49B
S104
L60
L26
L40
S19A
S60
S110
L69
L3
S19B
S72
S35
S36
S37
L66
S18
L63
S34
Mobil CEP Discovery
L49
S19C
S32
L52
L62
Fort Flatters
S24A
S67
Ouan Taredjeli Field
POLIGNAC BASIN
S33
S126
S25B
La Recullee Field
S26
Zarzaitine Field
S74B
L1
L48
L50
S81
S65A
Tiguentourine Field
S
75
Edjeleh Field
S66
S68
Taredert Field
B-2 Atshan Well
Sabhah
S83
S25A
S24B
S74A
S65B
Oubarakat Field
L68
S82
S79
S84A
S85
S86
L73
S84B
S80
L67
L64
L58
L67
L67
L76
L140
L141

MALI
Goundam
Gao
Mopti
Niamey
5°
0°
5°



CONCESSIONS (INCLUDING PERMITS GRANTED

SAHARA
PERMITS GRANTED

C.F.P.A. (Cie Francaise Des Petroles Algerie)
S1 S3A S3B S3C S5 S7A S7B S9A S9B S11A S112 B S27A S27B S52 S53 S66

S.N.REPAL (Societe Nationale de Recherches et d'Exploitation des Petroles en Algerie)
S2A S2B S4A S4B S6A S6B S8A S8B S10A S10B S12 S28 S29 S51

C.P.A. (Compagnie des Petroles d'Algerie)
S13 S14A S14B S15A S15B S16A S16B S16C S17 S18 S19A S19B S19C S33 S47A S47B S63

C.R.E.P.S. (Compagnie de Recherches et d'Exploitation de Petrole au Sahara)
S20A S20B S20C S21A S21B S22 S23 S24A S24B S25A S25B S26 S30 S31 S32 S46 S80

C.E.P. (Compagnie d'Exploitation Petroliere)
S34 S35 S36 S37 S38 S39 S40 S41 S42 S79

S.N.A.P. (Societe Nationale des Petroles d'Aquitaine)
S43A S43B S43C S69 S78

S.P.V. (Societe Petroles de Valence)
S44A S44B S55 S56A S56B S82 S84A S84B

PREP FRANCAREP AFROPEC (Societe de Prospection et d'Exploitations Petrolieres en Alsace Cie Franco Africaine d'Exploitations Petrolieres Filiate Francaise de Cities Service)
S45A S45B S45C S59A S59B S76A S76B S76C

PETROSAREP
S48 S58

COPEFA OMNIREX PHILLIPS (Cie des Petroles France Afrique Omnium de Recherches et d'Exploitation de Petrole)
S49A S49B S60 S71

S.A.F.R.E.P. (Societe Anonyme Francaise de Recherches et d'Exploitation de Petroles)
S50A S50B S50C S50D S50E S54 S57A S57B S68 S83 S85

PETROPAR FRANCAREP FRANDEL
S61

PETROPAR F.I.P. C.F.I.M.
S62

COPEFA
S64

S.N.REPAL FRANCAREP EURAFREP
S65A S65B

PETROPAR A.M.I.F.
S67 S70

COPAREX
S72 S81

C.F.P.A. PETROPAR ESSO
S73

FRANCAREP
S74A S74B S86

EURAFREP
S75

TOPCO CALASIATIC
S87

SAHARA (Permits Requested)

C.P.A.
S104 S117

C.P.A. PETROPAR FRANCAREP FRANDEL SAFREP
S112

C.F.P.A., S.P.V., SAFREP
S126

C.F.I.M. F.I.P.
S127

S.P.V.
S129 S131

FRANCAREP, S.N.P.A., COPEFA PHILLIPS, PREPA, EURAFREP, S.N.REPAL, S.P.V., SAFREP
S130

PETROPAR FRANCAREP FRANDEL
S110

ALGERIA
PERMITS GRANTED

S.N.REPAL
A1A A1B A1C A1D A1E

CAREP (Compagnie Algerienne de Recherches et d'Exploitation Petrolieres)
A2

ALGERIA (Permits Requested)

CAREP
A 10A A10B A10C

S.N.REPAL
A11A A11B A11C

PREPA FRANCAREP AFROPEC
A12A A12B

S.P.H.P. (Societe des Petroles des Mautes Plaines)
A13

LIBYA
PERMITS GRANTED

Esso Standard Libya, Inc.
L1 L3 L4 L5 L6 L7 L8 L48 L58

Nelson Bunker Hunt
L2 L65

Mobil Oil of Canada, Ltd.
L9 L10 L11 L12 L13 L14 L15 L50 L57 L62 L72

Libyan American Oil Company
L16 L17 L18 L19 L20

Compagnie des Petroles Total
L23 L24 L49 L61

Oasis Oil Company
L25 L26 L27 L28 L29 L30 L31 L32 L33 L59 L60 L71

B.P. Exploration Co. (Libya) Ltd.
L34 L35 L36 L37 L63 L64 L80 L81

Libya Shell N.V.
L38 L39 L40 L41 L52 L69 L70

Texaco Overseas California Asiatic Amoseas
L42 L43 L44 L45 L46 L47 L51 L73 L83

Gulf Oil Co. of Libya
L66 L67 L68 L79

Pan American Libyan Oil Co.
L74 L76 L84

Dea Wiag (Deutsche Erdoel)
L77

Elwerath Erdoelwerke
L78

5° 10° 15

5°
10°
15°
MEDITERRANEAN SEA
Bizerte
Bone
Bougie
Philippeville
Tunis
T4
Cap Bon Field
Setif
Constantine
A1B
CONSTANTINOIS BASIN
A1A
Batna
A1C
T1B
Biskra
A11B
A1E
T3
Sfax
T5
Skhirra
T6
S6A
S6B
S5
S7A
T2
El Oued
Touggourt
SIC BASIN
S64
S8B
PERMIAN FLEXURE
T1A
L38
L23
L34
L42
L83
L86
S52
S9B
S63
T1C
Ouargla
S73
L8
L61
L70
L39
S12
L30
L43
S112
S87
L60
L26
L40
S19A
L69
L3
S37
S35
S36
L66
L63
S34
L49
L52
L62
L78
S32
Fort Flatters
S24A
POLIGNAC BASIN
S33
S25B
S26
L1
L48
L50
Tripoli
L9

20°

40°

FRANCE

ITALY

SPAIN

R. S. F. S. R.

40°

TURKEY

ATLANTIC OCEAN

Mediterranean Sea

IRAN

30°

MOROCCO

ALGERIA

TUNISIA

IRAQ

30°

SAHARA

LIBYA

SAUDI ARABIA

23°27'

SP. SAHARA

Tropic of Cancer

Red Sea

20°

MAURITANIA

Map Area

20°

MALI

NIGER

CHAD

SENEGAL

GAMBIA

PORT. GUINEA

10°

AFRICA

20°

10°

0°

40°

50°

SOUTH ATLANTIC OCEAN

0°

Equator

35°

0 500 1000

STATUTE MILES

10°

10°

MACHA DRAFTING COMPANY
CARTOGRAPHERS • HOUSTON, TEXAS

10°

20°

30°

L28

L45

L27

L36

L29

L18

Benghazi

L15

L19

L7

L2

Gulf of Sirte

L89

L35

L41

L14

L46

L37

L33

86

L79

L87

L31

L4

L10

30°

L88

L24

L11

Marsa El Brega

L31

L25

L32

L16

L5

Madrak Field

Bahi-Dahra Field

L6

Amal Field

L51

L17

L12

L82

L20

New Discovery Pt. Late Essa Strike

L13

Essa Zeitan Field

L84

L11

L47

Beda Field

L59

L80

L57

L78

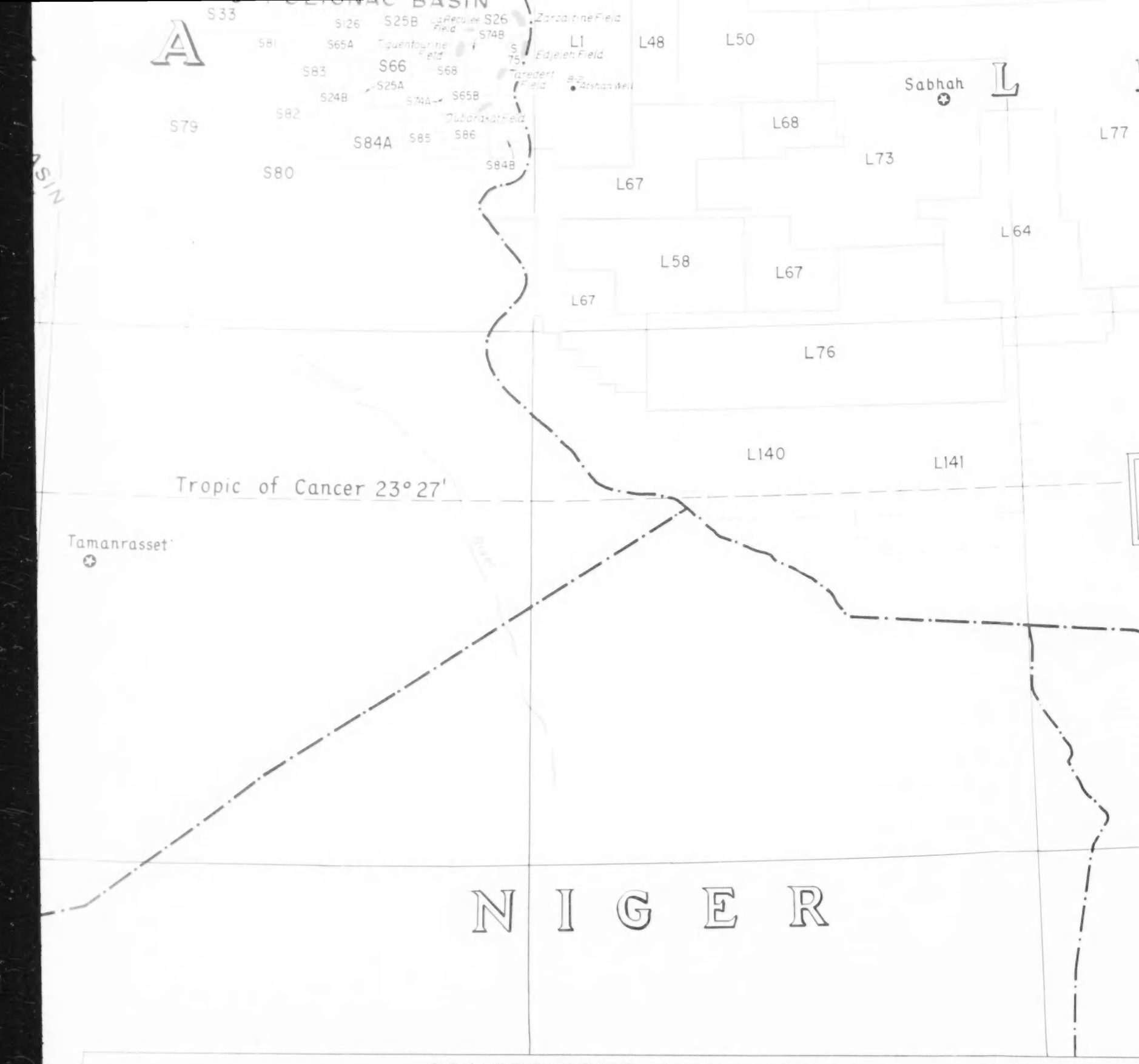
S-2

L142

L65

L81

REPUBLIC (EGYPT)



CONCESSIONS (INCLUDING PERMITS GRANTED AND

SAHARA
PERMITS GRANTED

C.F.P.A. (Cie Francaise Des Petroles Algerie)
S1 S3A S3B S3C S5 S7A S7B S9A S9B S11A S11B S27A S27B S52 S53 S66

S.N.REPAL (Societe Nationale de Recherches et d'Exploitation des Petroles en Algerie)
S2A S2B S4A S4B S6A S6B S8A S8B S10A S10B S12 S28 S29 S51

C.P.A. (Compagnie des Petroles d'Algerie)
S13 S14A S14B S15A S15B S16A S16B S16C S17 S18 S19A S19B S19C S33 S47A S47B S63

C.R.E.P.S. (Compagnie de Recherches et d'Exploitation de Petrole au Sahara)
S20A S20B S20C S21A S21B S22 S23 S24A S24B S25A S25B S26 S30 S31 S32

S.P.V. (Societe Petroles de Valence)
S44A S44B S55 S56A S56B S82 S84A S84B

PREP FRANCAREP AFROPEC (Societe de Prospection et d'Exploitations Petrolieres en Alsace Cie Franco Africaine d'Exploitations Petrolieres Filiate Francaise de Cities Service)
S45A S45B S45C S59A S59B S76A S76B S76C

PETROSAREP
S48 S58

COPEFA OMNIREX PHILLIPS (Cie des Petroles France Afrique Omnium de Recherches et d'Exploitation de Petrole)
S49A S49B S60 S71

S.A.F.R.E.P. (Societe Anonyme Francaise de Recherches et d'Exploitation de Petroles)
S50A S50B S50C S50D S50E S54 S57A S57B S68 S82 S91

S.N.REPAL FRANCAREP EURAFREP
S65A S65B

PETROPAR A.M.I.F.
S67 S70

COPAREX
S72 S81

C.F.P.(A.) PETROPAR ESSO
S73

FRANCAREP
S74A S74B S86

EURAFREP
S75

TOPCO CALASIATIC
S87

SAHARA (Permits Requested)

C.P.A.
S104 S117

C.P.A. PETROPAR FRANCAREP FRANDEL SAFREP

FRANCAREP, S.N.P.A., COPEFA PHILLIPS, PREPA, EURAFREP, S.N.REPAL, S.P.V., SAFREP
S130

PETROPAR FRANCAREP FRANDEL
S110

ALGERIA
PERMITS GRANTED

S.N.REPAL
A1A A1B A1C A1D A1E

CAREP (Compagnie Algerienne de Recherches et d'Exploitation Petrolieres)
A2

ALGERIA (Permits Requested)

CAREP
A 10A A10B A10C

S.N.REPAL
A11A A11B A11C

PREPA FRANCAREP AFROPEC
A12A

Nelson Bunker Hunt
L2 L65

Mobil Oil of Canada, Ltd.
L9 L10 L11 L12 L13 L14 L15 L50 L57 L62 L72

Libyan American Oil Company
L16 L17 L18 L19 L20

Compagnie des Petroles Total
L23 L24 L49 L61

Oasis Oil Company
L25 L26 L27 L28 L29 L30 L31 L32 L33 L59 L60 L71

B.P. Exploration Co. (Libya) Ltd.
L34 L35 L36 L37 L63 L64 L80 L81

Libya Shell N.V.
L38 L39 L40 L41 L52 L69 L70

Texaco Overseas California Asiatic (Amoseas)
L42 L43 L44 L45 L46 L47 L51 L73 L83

Compa (C.O
L82

Ausoni
L85

Libyan
L86 L8

LIBY

Gulf O
L136 L

Nelson
L130

Mobil
L143

Pan Am
L140

Shell O
L133 L

PER

L142 L65 L81

I B Y A

L72 L71

L77 L143 L144

L136 L130

25°

L85 L74

L133

UNITED ARAB REP.

NOTE: Libya's Petroleum Law calls for dropping 25 percent of all concessions after five years. More than one-half of current concessions, covering the north third of Libya, were granted in 1955.

20°

C H A D

SUDAN

AND REQUESTED)

Compagnia Ricerchi Idrocarburi (C.O.R.I.)
L82

Ausonia Mineraria
L85

Libyan Atlantic Co.
L86 L87 L88 L89

LIBYA (Permits Requested)

Gulf Oil Co. of Libya
L136 L141 L142

Nelson Bunker Hunt
L130

Mobil Oil of Canada, Ltd.
L143

Pan American Libyan Oil Co.
L140

Shell Oil Company
L133 L144

MOROCCO
PERMITS GRANTED

MOROCCO
(Permits Requested)

I.N.I.
M10A M10B

TUNISIA
PERMITS GRANTED

SEREPT (Societe de Recherches ed d'Exploitation des Petroles en Tunisie)
T1A T1B T1C

CONORADO
T2

SOM RIMROCK (Olii Minerali)
T3 T4 T5 T6

MAURITANIA
PERMITS GRANTED

PETROPAR
MA1

S.A.P. (Societe Africaine des Petroles)
MA2

SPANISH SAHARA
PERMITS GRANTED

Campsa Richfield Cities Service
SS30 SS39 SS40 SS43

Gulf Cepsa
SS9 SS10 SS16 SS47 SS51

Sohio Urquijo
SS48 SS52 SS53 SS56 SS60

Sun Champlin Pure Iberico
SS15 SS23

Caltex-INI
SS22 SS31 SS32 SS41 SS45 SS57

Tidewater-Urquijo
SS7 SS13 SS14 SS24

Union Iberico
SS1 SS2 SS8

Phillips
SS4 SS11

15°

SENEGAL
PERMITS GRANTED

SENEGAL MALI NIGER CHAD

Sea

S22-S23-S24A-S24B-S25A-
S25B-S26-S30-S31-S32

d'Exploitation de Petroles
S50A-S50B-S50C-S50D-S50E-

FRANCAREP-FRANDEL-
SAFREP

A11A-A11B-A11C

PREPA-FRANCAREP-AEROPEC
A12A

L42-L43-L44-L45-L46-L47-L51-
L73-L83

Bougie

Bone

Philippeville

Setif

Constantine
A1B

CONSTANTINOIS
BASIN

Batna

A1C

T1B

Tunis

T4

Cap Bon
Field

Biskra

A11A

A1D

A11B
A1E

S6A

S127

S6B

S7A

S56B

S62

S7B

S59B

S50D

El Oued

C BASIN

Touggourt

S64

S8B

S44B

S50E

S52

S9B

Ouargla

S63

S73

T1C

S12

S112

S87

T3

Sfax

T5

Skhirra

T6

T2

PERMIAN
FLEXURE

T1A

Tripoli

L9

L38

L23

L34

L42

L83

L86

L61

L8

L70

L39

L4

L30

L43

L25

L60

L26

L40

L69

L3

L66

L63

S18

S34

S35

S36

S37

L49

L52

L62

L78

Fort Flatters

S24A

S67

POLIGNAC BASIN

S33

S26

S25B

S74B

L1

L48

L50

S66

S68

S25A

S24B

S65B

Sabhah

L68

L77

S79

S84A

S85

S86

S84B

L73

S80

L67

L64

L58

L67

L67

L76

L140

L141

L25

PERMITS GRANTED

SENEGAL

PERMITS GRANTED

MALI

NIGER

CHAD

SENEGAL

GAMBIA

PORT. GUINEA

AFRICA

SOUTH ATLANTIC OCEAN

Equator

0 500 1000

STATUTE MILES

MACHA DRAFTING COMPANY
CARTOGRAPHERS • HOUSTON, TEXAS

Sea

10°

20°

30°

40°

50°

0°

35°

30°

25°

Gulf of Sirte

Benghazi

Marsa El Brega

L28 L45 L27 L36 L29 L18 L15 L7 L2 L19 L89 L35 L14 L41 L46 L37 L33 L87 L79 L4 L10 L88 L31 L24 L11 L16 L5 L32 L6 L12 L51 L82 L17 L20 L13 L84 L47 L59 L57 L80 L142 L65 L81 L72 L71 L143 L144 L136 L130 L85 L74 L133

Marsa El Brega Field

Bahi-Dahra Field

Amal Field

New Discovery by Lib Am Esso Sirte

Esso Zeltan Field

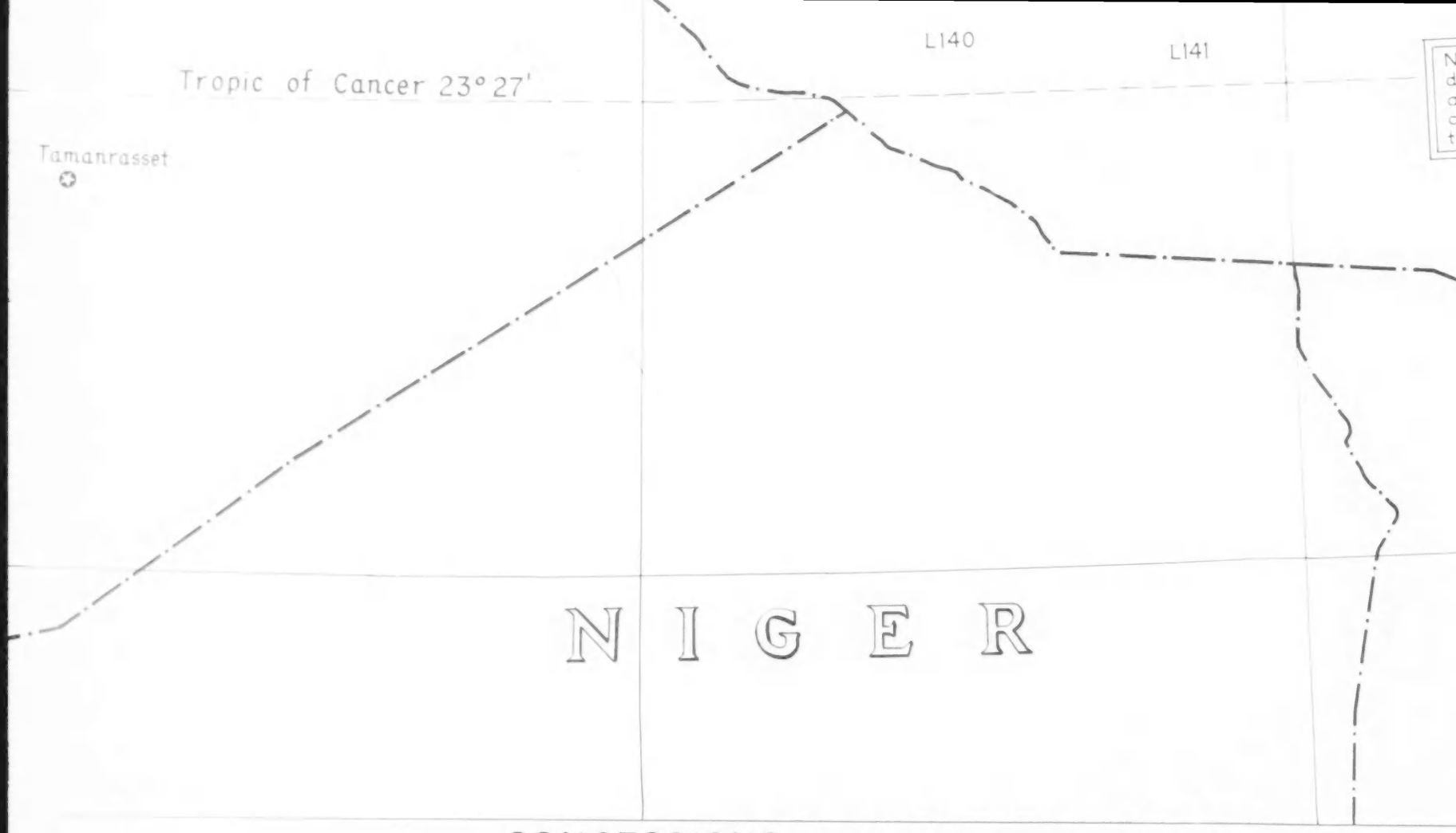
Hedra Field

B-1

B-2

UNITED ARAB REPUBLIC (EGYPT)

NOTE: Libya's Petroleum Law calls for



CONCESSIONS (INCLUDING PERMITS GRANTED AND

SAHARA
PERMITS GRANTED

C.F.P. A. (Cie Francaise Des Petroles Algerie)
S1 S3A S3B S3C S5 S7A S7B S9A S9B S11A S11B S27A S27B S52 S53 S66

S.N.REPAL (Societe Nationale de Recherches et d'Exploitation des Petroles en Algerie)
S2A S2B S4A S4B S6A S6B S8A S8B S10A S10B S12 S28 S29 S51

C.P.A. (Compagnie des Petroles d'Algerie)
S13 S14A S14B S15A S15B S16A S16B S16C S17 S18 S19A S19B S19C S33 S47A S47B S63

C.R.E.P.S. (Compagnie de Recherches et d'Exploitation de Petrole au Sahara)
S20A S20B S20C S21A S21B S22 S23 S24A S24B S25A S25B S26 S30 S31 S32 S46 S80

C.E.P. (Compagnie d'Exploitation Petroliere)
S34 S35 S36 S37 S38 S39 S40 S41 S42 S79

S.N.A.P. (Societe Nationale des Petroles d'Aquitaine)
S43A S43B S43C S69 S78

S.P.V. (Societe Petroles de Valence)
S44A S44B S55 S56A S56B S82 S84A S84B

PREP FRANCAREP AFROPEC (Societe de Prospection et d'Exploitations Petrolieres en Alsace Cie Franco Africaine d'Exploitations Petrolieres Filiale Francaise de Cities Service)
S45A S45B S45C S59A S59B S76A S76B S76C

PETROSAREP
S48 S58

COPEFA OMNIREX PHILLIPS (Cie des Petroles France Afrique Omnium de Recherches et d'Exploitation de Petrole)
S49A S49B S60 S71

S.A.F.R.E.P. (Societe Anonyme Francaise de Recherches et d'Exploitation de Petroles)
S50A S50B S50C S50D S50E S54 S57A S57B S68 S83 S85

PETROPAR FRANCAREP FRANDEL
S61

PETROPAR F.I.P. C.F.I.M.
S62

COPEFA
S64

S.N.REPAL FRANCAREP EURAFREP
S65A S65B

PETROPAR A.M.I.F.
S67 S70

COPAREX
S72 S81

C.F.P. A. PETROPAR ESSO
S73

FRANCAREP
S74A S74B S86

EURAFREP
S75

TOPCO CALASIATIC
S87

SAHARA (Permits Requested)

C.P.A.
S104 S117

C.P.A. PETROPAR FRANCAREP FRANDEL SAFREP
S112

C.F.P.A., S.P.V., SAFREP
S126

C.F.I.M. F.I.P.
S127

S.P.V.
S129 S131

FRANCAREP, S.N.P.A., COPEFA PHILLIPS, PREPA, EURAFREP, S.N.REPAL, S.P.V., SAFREP
S130

PETROPAR FRANCAREP FRANDEL
S110

ALGERIA
PERMITS GRANTED

S.N.REPAL
A1A A1B A1C A1D A1E

CAREP (Compagnie Algerienne de Recherches et d'Exploitation Petrolieres)
A2

ALGERIA (Permits Requested)

CAREP
A10A A10B A10C

S.N.REPAL
A11A A11B A11C

PREPA FRANCAREP AFROPEC
A12A A12B

S.P.H.P. (Societe des Petroles des Mautes Plaines)
A13

LIBYA
PERMITS GRANTED

Esso Standard Libya, Inc.
L1 L3 L4 L5 L6 L7 L8 L48 L58

Nelson Bunker Hunt
L2 L65

Mobil Oil of Canada, Ltd.
L9 L10 L11 L12 L13 L14 L15 L50 L57 L62 L72

Libyan American Oil Company
L16 L17 L18 L19 L20

Compagnie des Petroles Total
L23 L24 L49 L61

Oasis Oil Company
L25 L26 L27 L28 L29 L30 L31 L32 L33 L59 L60 L71

B.P. Exploration Co. (Libya) Ltd.
L34 L35 L36 L37 L63 L64 L80 L81

Libya Shell N.V.
L38 L39 L40 L41 L52 L69 L70

Texaco Overseas California Asiatic (Amoseas)
L42 L43 L44 L45 L46 L47 L51 L73 L83

Gulf Oil Co. of Libya
L66 L67 L68 L79

Pan American Libyan Oil Co.
L74 L76 L84

Dea Wiag (Deutsche Erdoel)
L77

Elwerath Erdoelwerke
L78

Compagn
C.O.R.
L82

Ausonia
L85

Libyan At
L86 L87

LIBYA

Gulf Oil C
L136 L14

Nelson Bu
L130

Mobil Oil
L143

Pan Amer
L140

Shell Oil C
L133 L144

MO
PERM

S.C.P. (Soc
Petroles
M1A M1B

SOMIP (S
Italienn
M2A M2B

B.R.P.M.
M4

10°

15°

NOTE: Libya's Petroleum Law calls for dropping 25 percent of all concessions after five years. More than one-half of current concessions, covering the north third of Libya, were granted in 1955.

20°

C H A D

SUDAN

15°

20°

ND REQUESTED)

Compagnia Ricerchi Idrocarburi
CORI
L82

Ausonia Mineraria
L85

Libyan Atlantic Co.
L86 L87 L88 L89

LIBYA (Permits Requested)

Gulf Oil Co. of Libya
L136 L141 L142

Nelson Bunker Hunt
L130

Mobil Oil of Canada, Ltd
L143

Pan American Libyan Oil Co.
L140

Shell Oil Company
L133 L144

MOROCCO
PERMITS GRANTED

S.C.P. (Societe Cherifienne des Petroles)
M1A M1B M1C M1D M1E

SOMIP (Societe Marocaine Italienne des Petroles)
M2A M2B M3A M3B

B.R.P.M.
M4

MOROCCO
(Permits Requested)

I.N.I.
M10A M10B

TUNISIA
PERMITS GRANTED

SEREPT (Societe de Recherches ed d'Exploitation des Petroles en Tunisie)
T1A T1B T1C

CONORADO
T2

SOM RIMROCK (Olii Minerali)
T3 T4 T5 T6

MAURITANIA
PERMITS GRANTED

PETROPAR
MA1

S.A.P. (Societe Africaine des Petroles)
MA2

SENEGAL
PERMITS GRANTED

S.A.P.
SE1 SE2 SE3 SE4 SE5 SE6

S.P.S. (Societe des Petroles du Senegal)
SE7 SE8 SE9 SE10

COPETAO
SE11 SE12

SPANISH SAHARA
PERMITS GRANTED

Campsa Richfield Cities Service
SS30 SS39 SS40 SS43

Gulf Cepsa
SS9 SS10 SS16 SS47 SS51

Sohio Urquijo
SS48 SS52 SS53 SS56 SS60

Sun Champlin Pure Iberico
SS15 SS23

Caltex INI
SS22 SS31 SS32 SS41 SS45 SS57

Tidewater Urquijo
SS7 SS13 SS14 SS24

Union Iberico
SS1 SS2 SS8

Phillips
SS4 SS11

Pan American INI
SS5 SS6

GAO INI
SS17 SS44

Atlantic
SS12